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EFFECTS OF OCEAN DISPOSAL ACTIVITIES ON MID-CONTINENTAL SHELF ENVIRONMENT OFF DELAWARE AND MARYLAND

Donald W. Lear, et al

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CONCLUSIONS

Observations were made over a period of approximately one year on two mid-temperate mid-continental shelf ocean dumpsites.

The hydrographic regime was found to generally approximate the classic winter isothermal-summer stratified system, but incursions of fresher water from the Delaware estuary and intrusion of offshore slope water were found to influence this hydrographic regime. Summer and winter density discontinuities may influence the distribution of conservative pollutants.

The distribution of metals in bottom sediments and organisms indicate these potentially toxic materials persist in bottom materials, and are apparently translocated as a result of hydrographic forces. This increases their potential toxicity to a relatively great area, with its indigenous biota. There is evidence of accumulation in benthic organisms, notably the mahogany clam, *Arctica islandica*, and the scallop, *Placopecten magellanicus*. There are indications of mortalities of the mahogany clam.

There is no evidence of accumulation of the nonconservative parameters observed.

The benthic substrate, medium to fine sands, does not apparently influence the distribution of the metals examined in this nondepositional environment. The microtopographic ridges and swales, observed directly from the submersible, may influence the local distribtuion of pollutants as well as biota.

Observations of the benthic infauna are as yet incomplete, and may influence current conclusions when analyzed.

Dumping operations of the acid waste source and of the sewage sludge materials are apparently separately distributed in the environment.

An area of at least 1000 square nautical miles, or 3600 square kilometers, was affected. The limits of the dispersion are not yet known.

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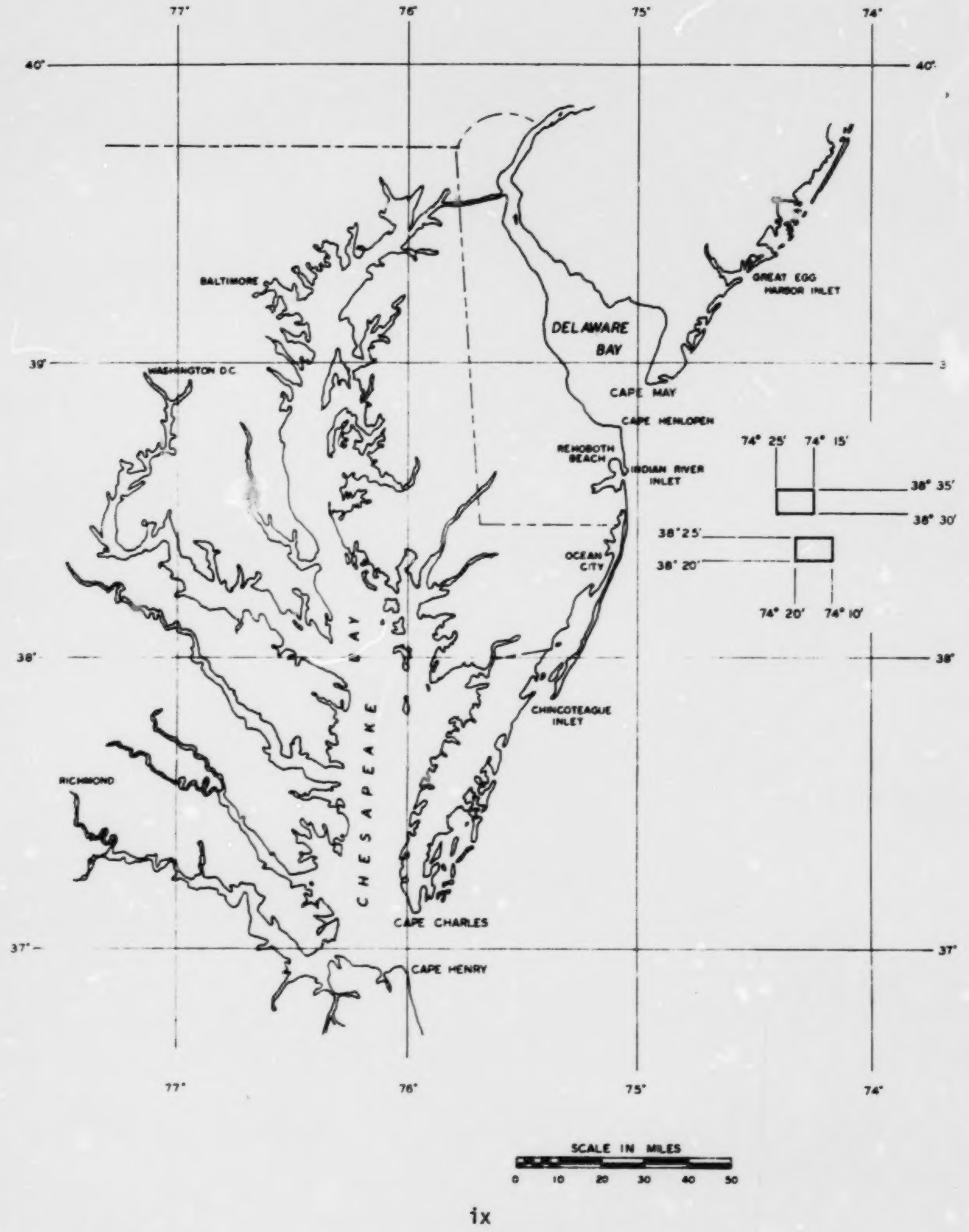
The officers and crew of the U.S. Coast Guard cutter Alert provided a hospitable and capable effort in the conduct of the summer 1974 cruise, Operation "Deep Six". We are especially grateful to Cdr. O'Brien, Cdr. Dux and Ens. Gadzly for their extraordinary interest, advice and support.

FIGURE 1

AREA OF STUDY


77°
76°
75°
74°
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40°
BALTIMORE
GREAT EGG
HARBOR INLET
DELAWARE
BAY
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WASHINGTON D.C.
CAPE MAY
CAPE HENLOPEN
REHOBOTH
BEACH
INDIAN RIVER
INLET
74° 25'
74° 15'
38° 35'
38° 30'
38° 25'
38° 20'
74° 20'
74° 10'
OCEAN
CITY
38°
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BAY
CHINCOTEAGUE
INLET
RICHMOND
CHESAPEAKE
CAPE CHARLES
37°
37°
CAPE HENRY
77°
76°
75°
74°
SCALE IN MILES
0
10
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30
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50

INTRODUCTION

The inception of environmentally regulated dumping by PL-92-532, the "Marine Protection Research and Sanctuaries Act of 1972," allows the issuance of permits for the disposal of materials at sea, but with the stipulation that the effects of such activities must be known.

In compliance with this mandate, EPA Region III and the EPA National Marine Water Quality Laboratory, Narragansett, Rhode Island, instituted a series of oceanographic cruises designed to evaluate the consequences of such activities off the coasts of Maryland and Delaware. Many other institutions participated in the endeavors, directly and indirectly, as noted in the acknowledgements.

The primary objectives of the field effort were to determine (1) the fate of the disposed materials in this marine environment, and (2) the effect of the materials on the ecological entities in the area. It was opted initially to examine the broad scale longer term effects, as contrasted to immediate and near field effects at the time of dumping. A multidisciplinary approach was made initially, with as many pertinent observations as practicable in the fields of physical, chemical biological, geochemical, and geological oceanography. As the fate and effects became known, consequent reduction of parameters could be made, with concomitant emphasis on parameters that indicated environmental change.

The first cruise, Operation "Quicksilver", was made in May 1973, with the objectives of assessing the environment at the muncipal sludge dumpsite, previous to the disposal of sludge. The area of investigation was restricted to the sludge dumpsite, with three reference stations presumably outside the effects of disposal activities.

Industrial acid wastes have been disposed at the acid waste site approximately 24 kilometers north-northwest of the sludge site since September 1968. Consequently the second expedition, Operation "Fetch" in November 1973, was expanded to evaluate, and possibly discriminate, the effects of both dumpsites. Some previous stations were occupied for continuity, and new stations added in the acid waste site.

The results of these cruises have been reported (Palmer and Lear, 1973; Lear, Smith and O'Malley, 1974; Lear, 1974).

It became apparent from these cruises that the affected area, as indicated by metals in the benthic environment, was of greater extent than the area surveyed. The third cruise, Operation "Ides" in March 1974, was designed to further explore the extent of the affected area, to develop a statistical basis for the evaluation of distributions, and to evaluate the forces responsible for the known distribution. The results of the cruise, as known to date, are reported as Appendix A of this report.

In August 1974, Operation "Deep Six" continued the investigation of the extent of materials dispersal, the causes thereof, and accumulation and/or amplification in the biota. This cruise was run nearly concomitantly with a joint NOAA-EPA cruise using a two-man submarine to determine first hand the conditions in the water column and benthos. The results to date of Operation "Deep Six" are reported as Appendix B to this report, and the cruise report of the submarine operations reported by Dr. David Folger, Middlebury College, Middlebury, Vermont, as Appendix C.

The uses of a given body of water may to some extent indicate the types and degree of stresses applied. In the area of consideration (see Figure 1), the waters are constantly traversed by major seagoing vessels, in coastwise and international trade, due to the location off Delaware Bay and the proximity to the Chesapeake.

This shelf environment is also extensively used by the ground fishery, as evidenced by the activity of domestic and foreign trawlers in the area. The sea clam fishery (Spisula solidissima) is inshore of the release zones. In addition to the already exploited fishery, sea scallops, mahogany clams, squid, rock crabs, Jonah crabs, and lobster are found in the area, but are currently not exploited.

In summer, sport fishermen are evident, after bluefish, bonita, dolphin, and, offshore of this area, the billfishes. Some winter sport codfishery is found in this region.

Of ecological concern is the observation of these areas as spawning and nursery areas for many species.

Military operations have been observed in this area, and the extent and usage of this environment for such purposes are generally unknown.

Recently this area has been considered as a major potential for petroleum exploration and production. The exploration and production sites, while at present not specifically defined, seem to overlap the areas affected by disposal activities.

From consideration of the above known uses of this area, possible multiple impacts must be considered in the overall ecological evaluation. With respect to regulatory responsibilities, it becomes important to discriminate the various sources of stress, as well as the overall effect.

This report summarizes the conclusions from data and observations at an arbitrary point in time of a continuous study. Many samples and data, primarily biological in nature, remain to be analyzed, and may affect further conclusions.

THE DISTRIBUTION OF DUMPED MATERIALS

One aspect of this program, the distribution of dumped materials, was to determine the distribution of the materials after release. The short term effects, immediately after dumping in the water column, were not attempted by this program. These have, however, been done by the DuPont Company (DuPont, 1972) and by the Marine Science Consortium (Champ, 1974). Generally it is indicated that in summer when the thermocline is established, the materials penetrate to this thermocline and there reside, are further dispersed horizontally to an unknown extent and ultimately penetrate the thermocline and settle to the bottom. This has been modeled by Hydroscience Company (DuPont, 1972) and has also been observed visually in dives of the submersible, as reported in Appendix C of this report.

This program, however, is designed to look at the long term effects of the dumping of these materials. For this purpose, the conservative materials, especially the metals, were used as tags of the released materials. This was done because they are dumped in significant quantities and the relative amounts of metals from the acid waste source and from the municipal sludge source may assist in discriminating the relative effects of dumping from these two discrete sources only a few kilometers apart. The annual inputs of the metals to this system are shown in Table 1.

The March and August, 1974 cruises indicated intrusions of slope or other offshore water into this area from the east. This has also

Table 1

Annual Input Delaware Dumpsites

DuPont*	Total Input	Philadelphia
118,000,000	gal/yr	150,000,000
446,700,000	l/yr	568,000,000
1.19	spec grav	1.03
531,573,000	kg/yr	584,500,000

Specific Metal Input

		%			%
Fe	21,360,000	95.8	kg/yr	946,000	4.2
Cu	2,400	2.8	"	83,150	97.2
Cr.	39,600	34.4	"	75,670	65.6
Al	364,000	25.0	"	1,094,000	75.0
Ag	270	10.4	"	2,314	89.6
Mn	572,000	87.5	"	81,400	12.5
Pb	5,630	3.7	"	145,000	96.3
Co	4,800	35.5	"	8,740	64.5
Ni	4,752	10.2	"	41,655	89.8
V	74,300	97.1	"	2,226	2.9
Cd	338	5.2	"	6,200	94.8
Zn	18,300	5.2	"	334,000	94.8
Ti	733,000	99.2	"	5,851	0.8

* Estimates based on DuPont reports submitted for period February 6 - July 11, 1974

been noted by Myers (1974). In addition to the impedance of distribution of dumped materials by the density discontinuities exhibited by thermoclines, these intrusions may act vertically, rather than horizontally, as density discontinuities in affecting the distribution of metals. The coincidence of the warm water plug in the southeast sector of the study area in March 1974, reported in Appendix A, Operation "Ides", and the distribution of the metals on the bottom indicate a coincidental pattern. There are insufficient data currently to definitely ascribe these two distributions, but the indications are strong enough to establish a working hypothesis for experimental design purposes. The paucity of data on tidal currents at the moment precludes conclusions on the shorter term benthic distribution of the metals by these causes.

The benthic environment was characterized as a relatively monotonous plain of medium to fine sands, as indicated by recording fathometers aboard ship. The variability of results in metals concentrations from five replicate bottom grabs, made while the ship was drifting, indicated there may be a microtopography of smaller ridges and swales, that would not be detected by the usual bathymetric methods aboard ship, because the amplitude of the microtopography would be smaller than the resolution afforded on the rolling ship. This hypothesis was confirmed by direct observation of using the submersible as reported in Appendix C. There appear to be small ridges and swales in the order of magnitude of a meter, crest to crest, and in the order of magnitude of centimeters from trough to crest. This microtopography presumably could affect the deposition of the metals. The great prevalence of iron in these wastes with its tendencies to create a floc and to scavenge other materials within the floc, would lead to a hypothesis that this floc material would be more likely to accumulate in these small troughs and be relatively clear on the ridges. The direct observations using the submersible have not yet clearly established whether this hypothetical distribtuion actually exists.

Measurements have been made of such nonconservative materials as phosphorus and nitrogen compounds, pH, and dissolved oxygen. There appears to be no apparent accumulation of these materials in the water column, even immediately above the bottom. There does appear to be detectable accumulation of the conservative metals, as indicated in Appendix A and Appendix B, and the earlier reports (Palmer and Lear, 1973; Lear, Smith and O'Malley, 1974; Lear, 1974). Possibly organohalogens, especially PCB, and organic carbon in sediments may on further investigation be found to be increasing as a result of dumping activities. These conclusions are drawn from the results of the March Operation "Ides" cruise and the August Operation "Deep Six" cruise, reported in Appendices A and B of this report.

The contoured distribution of each of the various metals appeared to be fairly coincidental on each cruise, but appeared to be in different locations on various cruises. To determine whether this was a statistically sound observation, the distribution of iron on Operation "Ides" was analyzed using the Mann-Whitney U-statistic to discriminate between the areas of high concentration of iron and the areas of low concentration of iron. The high areas were Stations B, 8 and 2, and the low stations on that cruise were Stations A, C, 14, E, 9, and 17. The Mann-Whitney test showed a significant difference between these two sets of stations ($U=15$; $N_1=16$, $N_2=15$; $P > 0.05$). These same stations were tested using the same statistical procedure with data from Operation "Fetch" reported earlier (Lear, Smith, O'Malley, 1974) and it was found the U-statistic between the same sets of stations was not significantly different. The same stations were tested on Operation "Deep Six" and found not to be significantly different. There were, however, on Operation "Deep Six" other statistically discrete areas of high and low concentrations of iron as reported in Appendix B. This would indicate that the materials were not firmly depositing on the bottom but rather were moved about from time to time, presumably as a function of tidal current and storm activity. The rates and directions of this translocation of bottom materials are not yet known in detail. This mobility of these potentially toxic materials on the bottom would indicate they are potentially capable of affecting extremely large areas, depending upon their residence time at any given location and the relative dispersion and dilution during translocation.

The taking of beach-worn cobbles during Operation "Ides", reported in Appendix A, indicates this environment is not presently depositional and that these materials being deposited are probably not being buried.

While the discrete distributions of the given metals varied from cruise to cruise, some areas were consistently more affected than others. The acid waste site and the stations immediately adjacent to it to the northeast and west showed evidence of metal deposition, the greatest being in the acid site. In the sludge site, evidence of increased metals was consistently found within the release area and to the southeast, south and southwest of this site. There appeared to be a discontinuity between the two release sites, in which metals buildup was not found.

In the areas so far examined, approximately 1000 nautical square miles or 3600 square kilometers have indicated accumulations of metals. The eastward, westward and southwestward extent of this distribution is not yet known.

Replicate samples of bottom sediments were taken during Operation "Ides" (Appendix A) to determine whether there were any relationships between metals concentrations and particle size. Plots of the median Phi diameters from 55 samples, representing all stations, were plotted against manganese, lead and mercury concentrations for each sample. No obvious relationship existed between median Phi and these three metal parameters. It was hypothesized that smaller particles would accumulate in the small troughs and larger particles be representative of the crests in the microtopography, and presumably the floc with its concomitant metals would be in the troughs. This would have resulted in a relationship between sediment size and metals concentration, either a linear relationship or a bimodal distribution. Such was apparently not the case, as indicated from data by current bottom grab sampling techniques. Possibly selective sampling using a submersible and direct visual observation of the sample acquisition may yield further information.

In an earlier cruise (Lear, Smith, O'Malley, 1974) a relationship between iron and other metals was noted. This could indicate common behavior of these materials by the time they reach the bottom and may discriminate sources of these materials. These relationships were examined using data from all previous cruises, shown in Table 2. Iron and mangenese, iron and zinc, iron and lead, and iron and chromium showed statistically linear regressions. Iron compared with mercury, copper and nickel did not consistently show the statistically significant relationship. It should be noted that mercury, copper and nickel were in low concentrations compared with the other materials. As iron is released through dumping activities in much greater concentrations than these other metals, an increase in slope should result if there is an accumulation of these materials. Over the period of these operations, approximately nine months of observations, no trends in increase of slope can be noted.

Another approach to determining whether metals were increasing as a function of time was made by comparing (1) the mean of all the statistically significant high concentration stations and each metal as a function of time, (2) with the mean for the lower concentration stations (3) with the mean of all stations, each cruise, and (4) the maximum values observed on any given cruise. These results are shown in Table 3. No apparent trends as a function of time are evident, with the possible exception of the increase of mercury in the bottom sediments. This relatively short period of observation, nine months, would not be expected to show startling increases over such a large area of bottom.

Table 2

Relationships of Metals in Sediments
Regression Equations

Iron/Manganese			
Operation "Fetch" (11/73)	$Fe = 8.63 + 0.0095\ Mn$	t = 6.63**	d.f. = 11
Operation "Ides" (3/74)	$Fe = 11.91 + 0.0132\ Mn$	t = 5.23**	d.f. = 57
Operation "Deep Six" (8/74)	$Fe = 16.95 + 0.0051\ Mn$	t = 2.59*	d.f. = 56
Iron/Zinc			
Operation "Fetch"	$Fe = 1.12 + 0.00162\ Zn$	t = 5.24**	d.f. = 11
Operation "Ides"	$Fe = 0.003\ Zn - 0.194$	t = 29.46**	d.f. = 57
Operation "Deep Six"	$Fe = 0.002\ Zn - 1.21$	t = 8.42**	d.f. = 56
Iron/Lead			
Operation "Fetch"	$Fe = 0.002\ Pb - 1.55$	t = 5.08**	d.f. = 11
Operation "Ides"	$Fe = 0.0013\ Pb + 1.55$	t = 6.59**	d.f. = 57
Operation "Deep Six"	$Fe = 0.0009\ Pb + 0.87$	t = 4.60**	d.f. = 56
Iron/Chromium			
Operation "Fetch"	$Fe = 0.84 + 0.0006\ Cr$	t = 2.65*	d.f. = 11
Operation "Deep Six"	$Fe = 0.17 + 0.0067\ Cr$	t = 11.95**	d.f. = 56
Iron/Mercury			
Operation "Ides"	$Fe = 0.018 - 0.00003\ Hg$	t = 2.34*	d.f. = 31
Operation "Deep Six"	$Fe = 0.42 + 0.00014\ Hg$	t = 1.42	d.f. = 55
Iron/Copper			
Operation "Deep Six"	$Fe = 0.0008\ Cu - 1.76$	t = 1.42	d.f. = 53
Iron/Nickel			
Operation "Deep Six"	$Fe = 0.000006\ Ni + 1.33$	t = 1.23	d.f. = 56

Table 3

Mean Concentrations of Metals in Sediments

		Operation "Quicksilver" 5/73	Operation "Fetch" 11/73	Operation "Ides" 3/74	Operation "Deep Six" 8/74
Iron -	Mean High Stations	-	-	2,601	4,157
	Mean Low "	-	-	1,324	2,299
	Mean All "	-	2,600	1,918	2,886
	Maximum	-	6,490	10,750	4,900
Mn -	Mean High Stations	-	-	58.5263	41.9651
	Mean Low "	-	-	26.5128	20.8221
	Mean All "	28.78	33.33	37.000	31.5791
	Maximum	-	72	188	95
Zn -	Mean High Stations	-	-	7.6896	8.9758
	Mean Low "	-	-	3.4827	3.501
	Mean All "	7.00	5.33	5.59	5.1338
	Maximum	-	71	11	12.5
Pb -	Mean High Stations	-	-	6.57	5.2183
	Mean Low "	-	-	2.89	2.4625
	Mean All "	<1	3.59	4.12	3.3328
	Maximum	-	8	14	8.8
Ni -	Mean High Stations	-	-	-	2.4431
	Mean Low "	-	-	-	0.9165
	Mean All "	<1	≅1	≅1.2	1.3450
	Maximum	-	2	16	3.4
Cd -	Mean High Stations	-	-	-	0.1144
	Mean Low "	-	-	-	0.0643
	Mean All "	<1	<1	<1	0.0880
	Maximum	-	<1	<1	0.27
Cr -	Mean High Stations	-	-	5.5500	2.9863
	Mean Low "	-	-	1.9711	1.6644
	Mean All "	2.11	2.50	2.3362	2.0150
	Maximum	-	5	11	5
Cu -	Mean High Stations	-	-	-	1.5700
	Mean Low "	-	-	-	0.3002
	Mean All "	<1	<1	<1	0.6343
	Maximum	-	1	12	2.8
Hg -	Mean All Stations	<0.01	<0.01	0.032	0.83
	Maximum	-	0.04	0.228	1.1

It should be noted that the preceding discussion is of metals in sediments and does not include the fate, distribution or effect of metals in any of the biota.

Summarizing the general trends from the data on the fate and dispersal of dumped materials into this mid-continental shelf environment indicates that in summer, with the thermocline acting as a density discontinuity, materials are released, presumably in the release zones, settle to the thermocline, are dispersed by tidal currents over the order of magnitude of several days before penetrating through the thermocline and being released to settle on the bottom. In winter, with no thermocline development, presumably materials would settle relatively rapidly to the bottom, except when density discontinuities are induced into this area, either through intrusions of offshore, warmer Gulf Stream or slope water or by intrusions of less saline estuarine sources from the Delaware estuary, to form vertical pycnoclines. These may affect the ultimate distribution of these materials on the bottom.

There is strong indication, (1) by direct observation as a function of time, (2) by inference with the relatively large size of the sediment particles, and (3) by direct visual observations of the floc material, that the material at the bottom is not buried, but at or just above the sediment-water interface, and is translocated to other areas, the extent of which is not yet known, by tidal current action or by storm surge movement. These metals, known to be conservative in their properties and potentially toxic to organisms, show the greatest potential hazard to the indigenous biota of all materials released at the present time.

EFFECT OF DUMPED MATERIALS

The effect of disposed materials on marine biota may be viewed in two time frames (1) short term, measured in minutes, hours and days, and (2) long term, measured in months and years. Short-term effects are best studied by coordinating observations with disposal operations. At the Delaware ocean disposal sites materials are dumped from moving barges. Observations should be made before, during and after a dump with primary emphasis placed on studying water column organisms. The main concern is estimating the toxic properties and extent of impact as the disposed materials mix and disperse into sea water. Long-term effects are best studied by selecting conservative parameters, primarily properties of the benthic environment, at stations spaced within and around dumpsites. These parameters should be sampled for a time period sufficient to discriminate natural fluctuations from changes imposed by dumping activities. The main concerns are accumulations of nondegradable dumped materials and estimations of environmental damage associated with these accumulations.

Environmental Protection Agency efforts have focused on the long-term effects. We want to know if contaminants are accumulating in the benthic environment. If so, how large an area is affected? We need to know present levels so as to follow future trends. If trends exist, what is their environmental significance?

Large quantities of various metals are dumped at these sites annually (Table 1). Animals and sediments within and around these sites have been analyzed for evidence of metal accumulation. On the spring '74 cruise, Operation "Ides", an area exceeding 1000 square miles was studied. Of 13 metals examined, 11 clearly indicated accumulations in animals and/or sediments in the vicinity of one or both dumpsites. Some of these metals are introduced predominantly by one or the other dumper, for example DuPont dumps 97% of the vanadium while Philadelphia dumps 95% of the cadmium (Table 1). These metals may serve as useful tracers for the dumped materials. Four such metals (Fe, Mn, V, and Ti) of DuPont waste, and five such metals (Cu, Ag, Ni, Cd, and Zn) of Philadelphia sludge showed statistically significant distribution patterns in the "Ides" study area (Tables 4 and 5). Some of these tracers displayed elevated concentrations in shellfish in areas extending from the dumpsites to the limits of the area covered by the "Ides" cruise. Vanadium levels in the tissues of the clam, Arctica islandica, and the scallop, Placopecten magellanicus, clearly show this pattern (Figures 2 and 3). Presumably these animals were exposed to DuPont wastes. Prevailing currents should sweep these wastes southwest from the dumpsite. Significantly, these tissue levels remain elevated at the farthest station southwest of the DuPont site. The "Ides" cruise was not extensive enough to permit delineation of the area influenced by DuPont's waste.

Some of the metals characteristic of Philadelphia sludge, e.g., Cd and Zn (Figures 4, 5, 6, and 7) displayed elevated concentrations in clams and scallops from the dumpsite area. However, these patterns are not clearly associated with the dumpsite. There are several possible reasons why these trends are not as definitive as those associated with DuPont wastes. Philadelphia had used the site for less than one year

Table 4

Analysis of Variance Results for Metal Levels in *Arctica islandica* Collected in Spring 1974 in Vicinity of Delaware Dumpsites

Metal	F level	Significance
Vanadium	33.54	.01
Zinc	6.34	.01
Cadmium	5.12	.01
Silver	3.07	.01
Copper	3.02	.01
Chromium	2.80	.01
Manganese	2.74	.01
Cobalt	2.25	.01
Nickel	1.95	.05
Titanium	1.92	.05
Aluminum	1.62	--
Iron	1.36	--
Lead	1.29	--

Table 5

OPERATION "IDES"

Metals in Scallops
ppm/dry wt.

Metal	F ratio	Significance
V	11.885	.01
Cd	6.896	.01
Zn	5.376	.01
Ni	5.300	.01
Cu	4.194	.01
Cr	3.130	.01
Ag	3.096	.01
Ti	2.832	.01
Mn	2.347	.01
Al	2.088	.05
Fe	1.787	.05
Pb	1.434	--
Co	1.117	--

FIGURE 2

OPERATION "IDES"
ARCTICA
METAL CONCENTRATION
VANADIUM
ppm dry wt

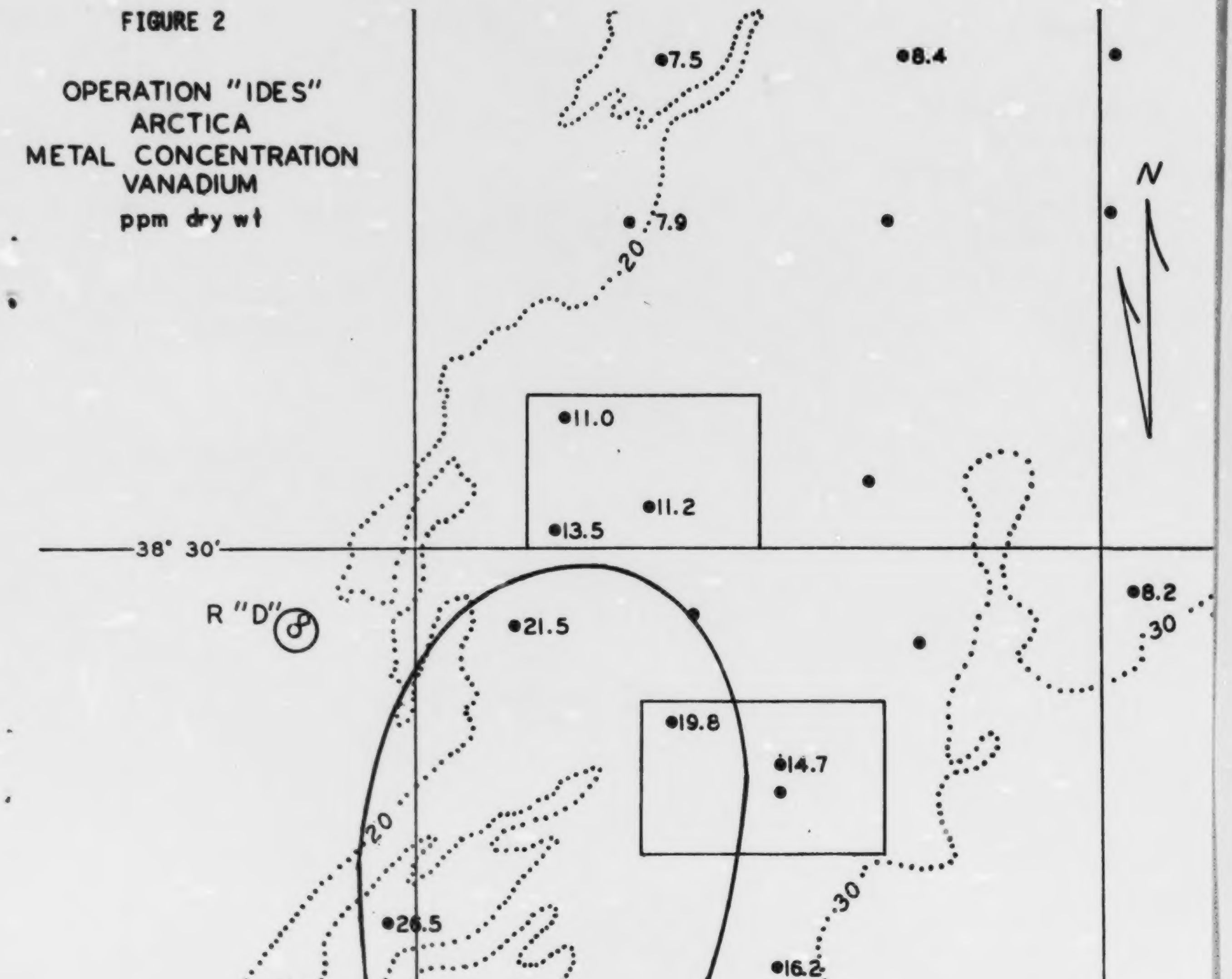

7.5
8.4
7.9
20
N
11.0
11.2
13.5
38° 30'
R "D"
21.5
8.2
30
19.8
14.7
20
30
26.5
16.2
19.5
5.9
5.5
40
30
40
21.4
9.4
74° 30'
74° 00'
50
38° 00'
20
100

FIGURE 3

OPERATION "IDES"
SCALLOP
METAL CONCENTRATION
VANADIUM
ppm dry wt

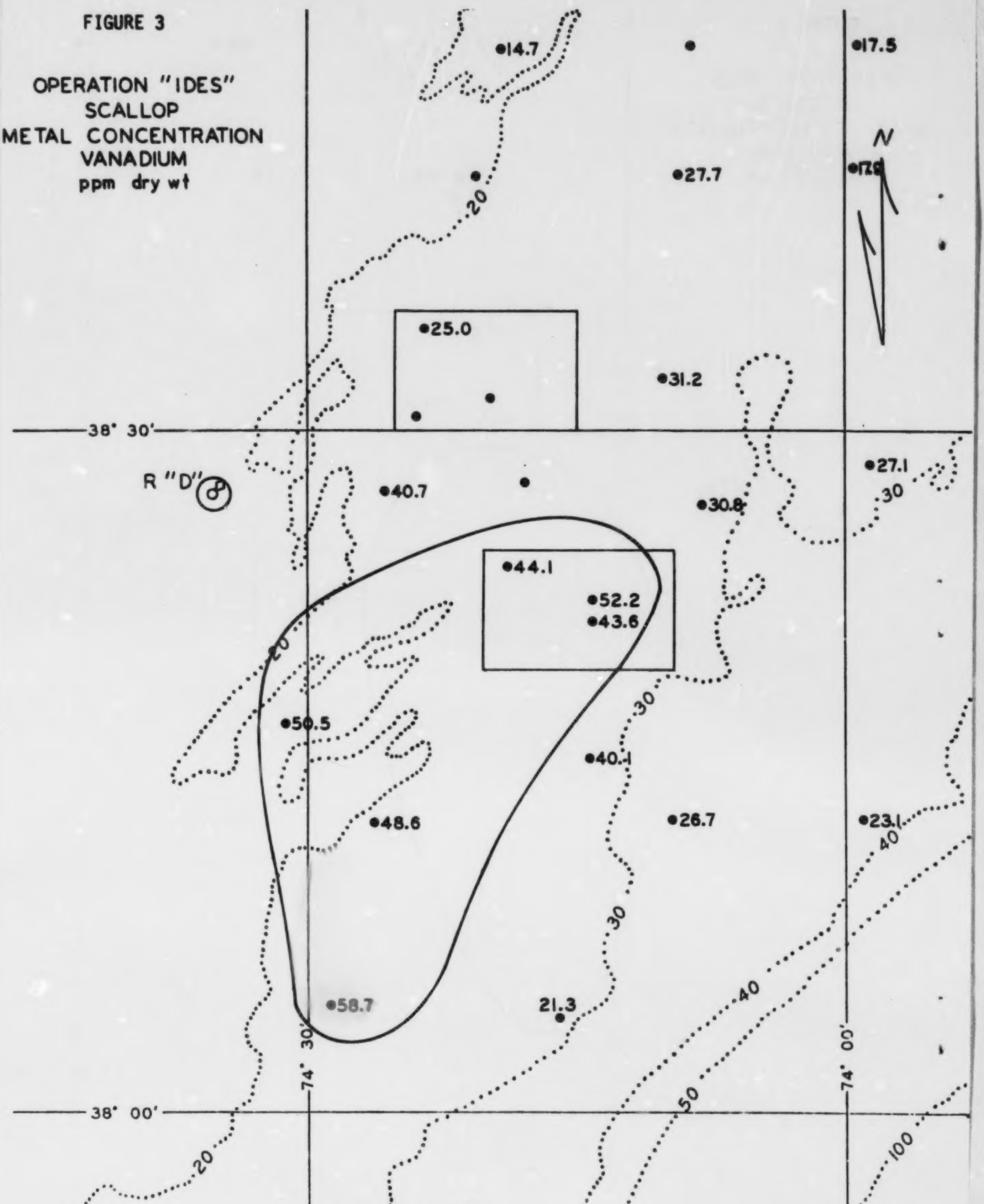
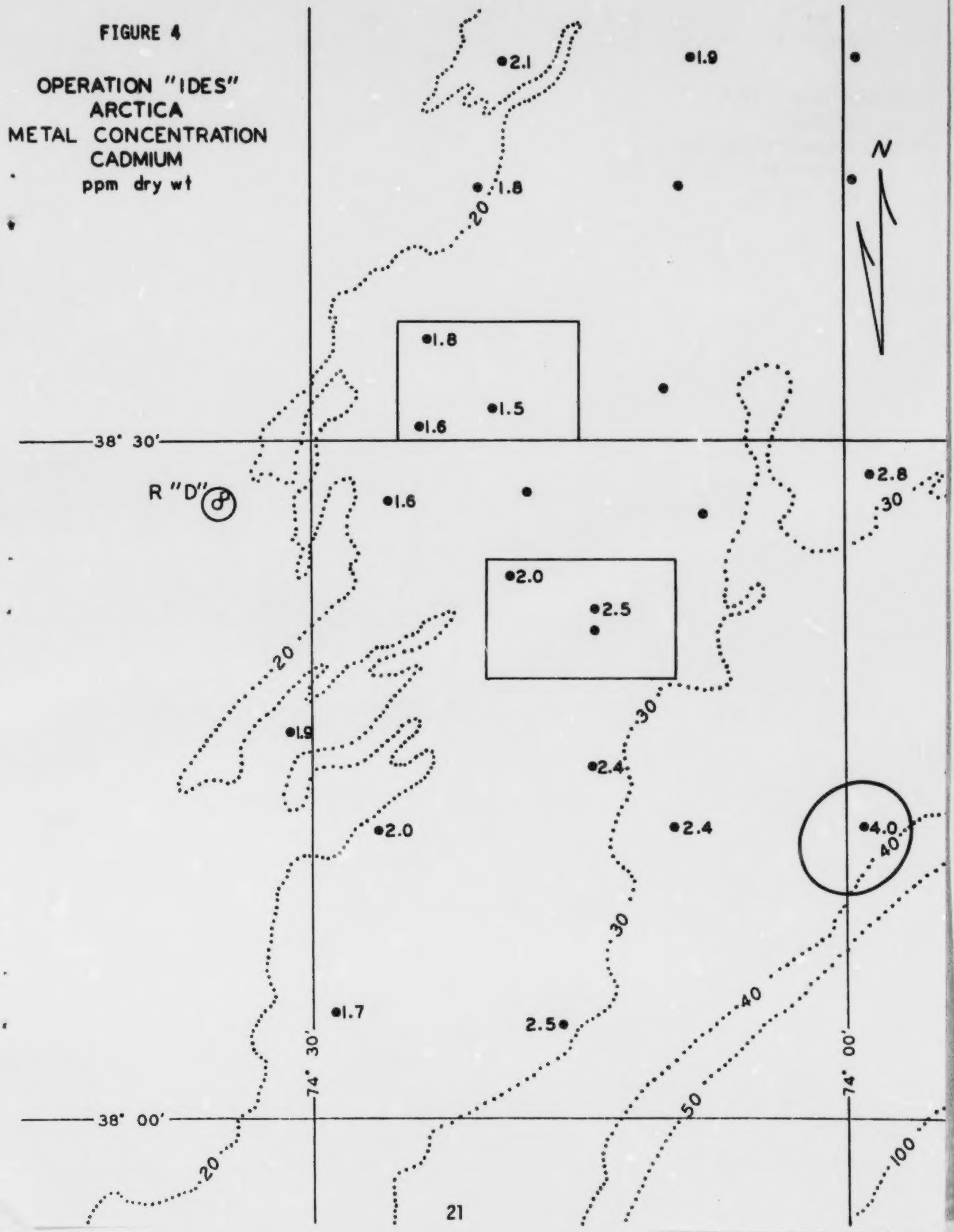

14.7
17.5
N
17.8
27.7
20
25.0
31.2
38° 30'
27.1
R "D"
40.7
30.8
30
44.1
52.2
43.6
20
30
50.5
40.1
48.6
26.7
23.1
40
30
40
58.7
21.3
74° 30'
74° 00'
50
38° 00'
20
100

FIGURE 4

OPERATION "IDES"
ARCTICA
METAL CONCENTRATION
CADMIUM
ppm dry wt



2.1
1.9
N
1.8
20
1.8
1.5
1.6
38° 30'
R "D"
1.6
2.8
30
2.0
2.5
20
30
1.9
2.4
2.0
2.4
4.0
40
30
1.7
2.5
40
74° 30'
74° 00'
50
38° 00'
20
100

FIGURE 5

OPERATION "IDES"
SCALLOP
METAL CONCENTRATION
CADMIUM
ppm dry wt

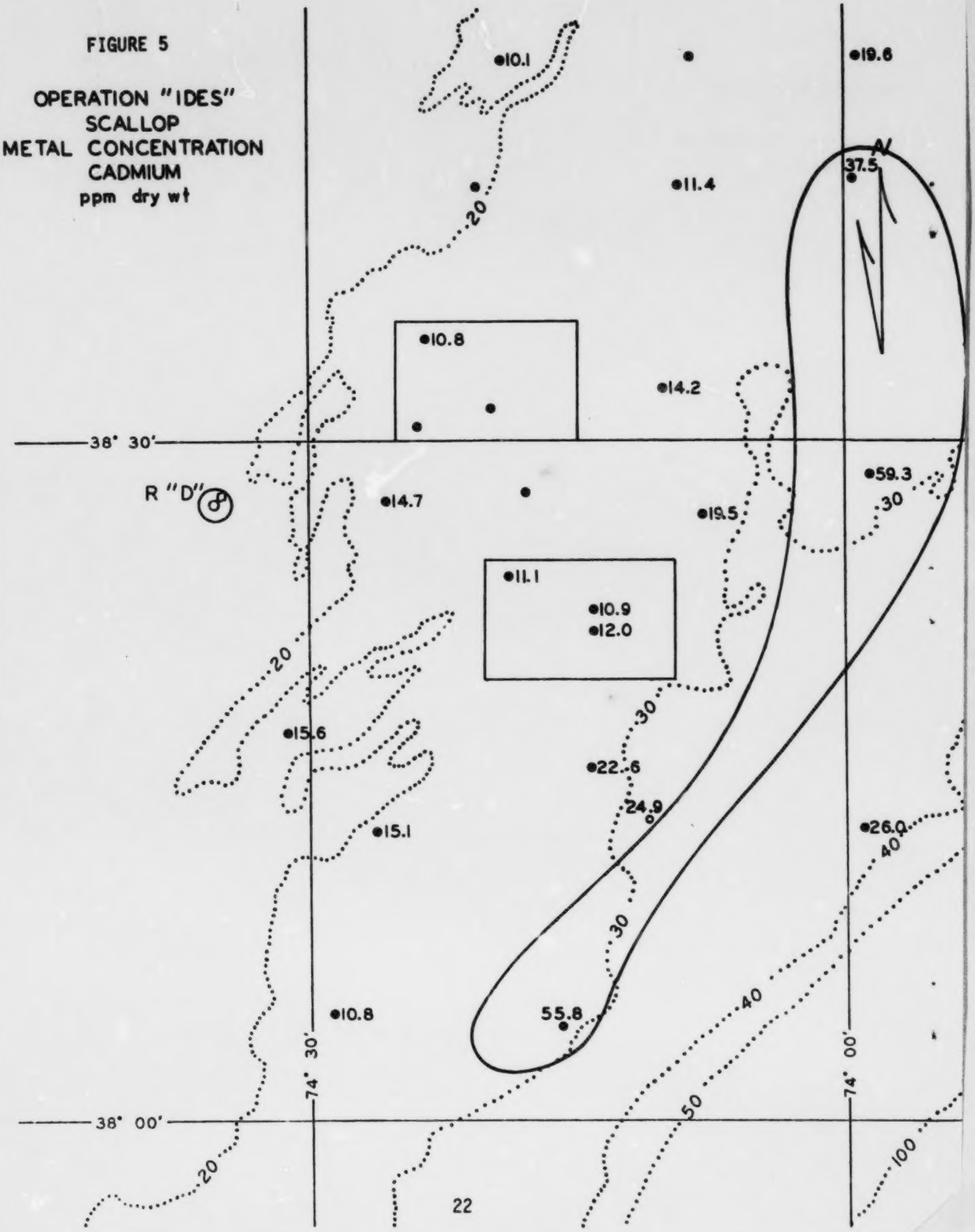
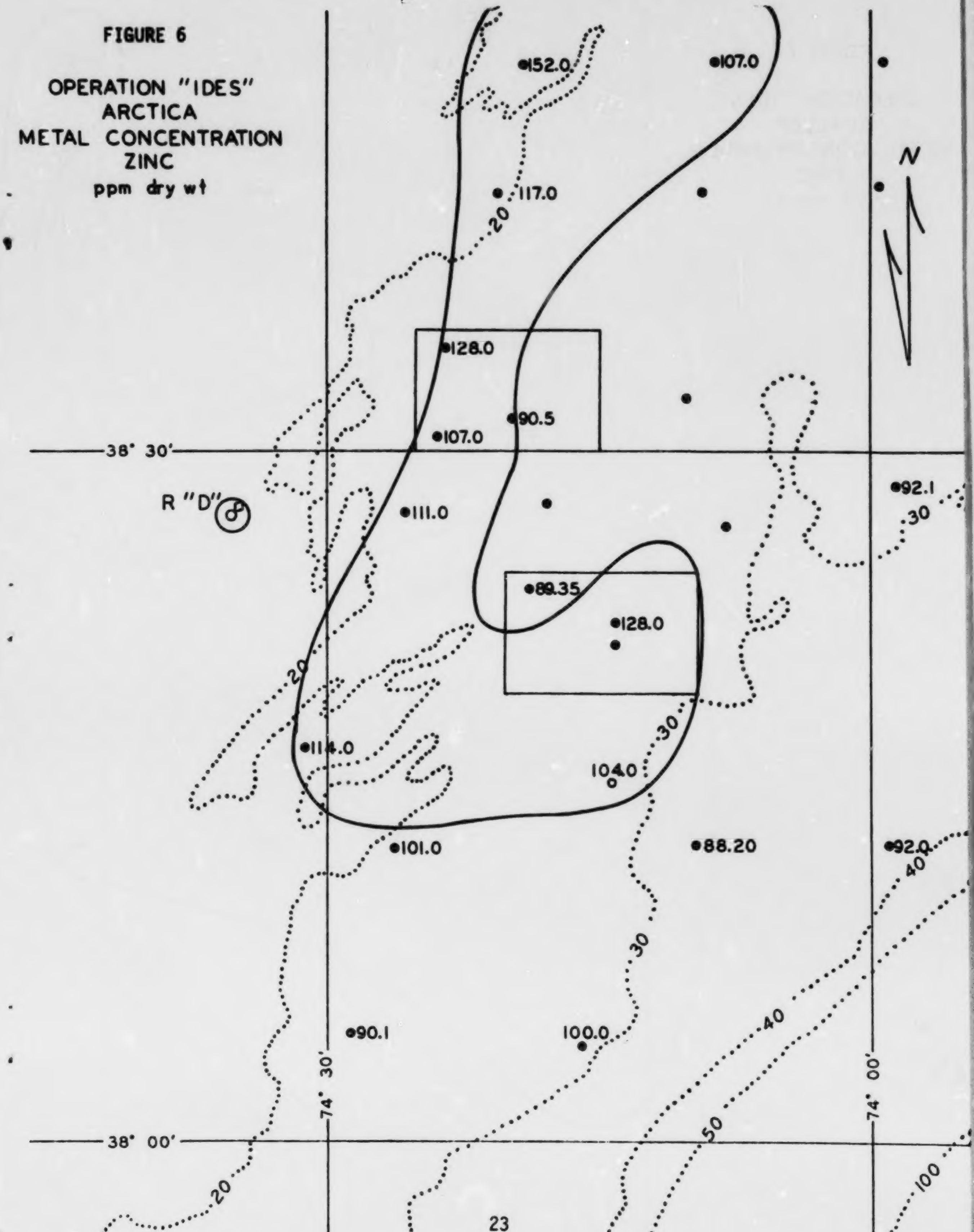

10.1
19.6
37.5
11.4
20
10.8
14.2
38° 30'
R "D"
59.3
30
14.7
19.5
11.1
10.9
12.0
20
30
15.6
22.6
24.9
15.1
26.0
40
30
10.8
55.8
40
74° 30'
74° 00'
50
38° 00'
20
100

FIGURE 6

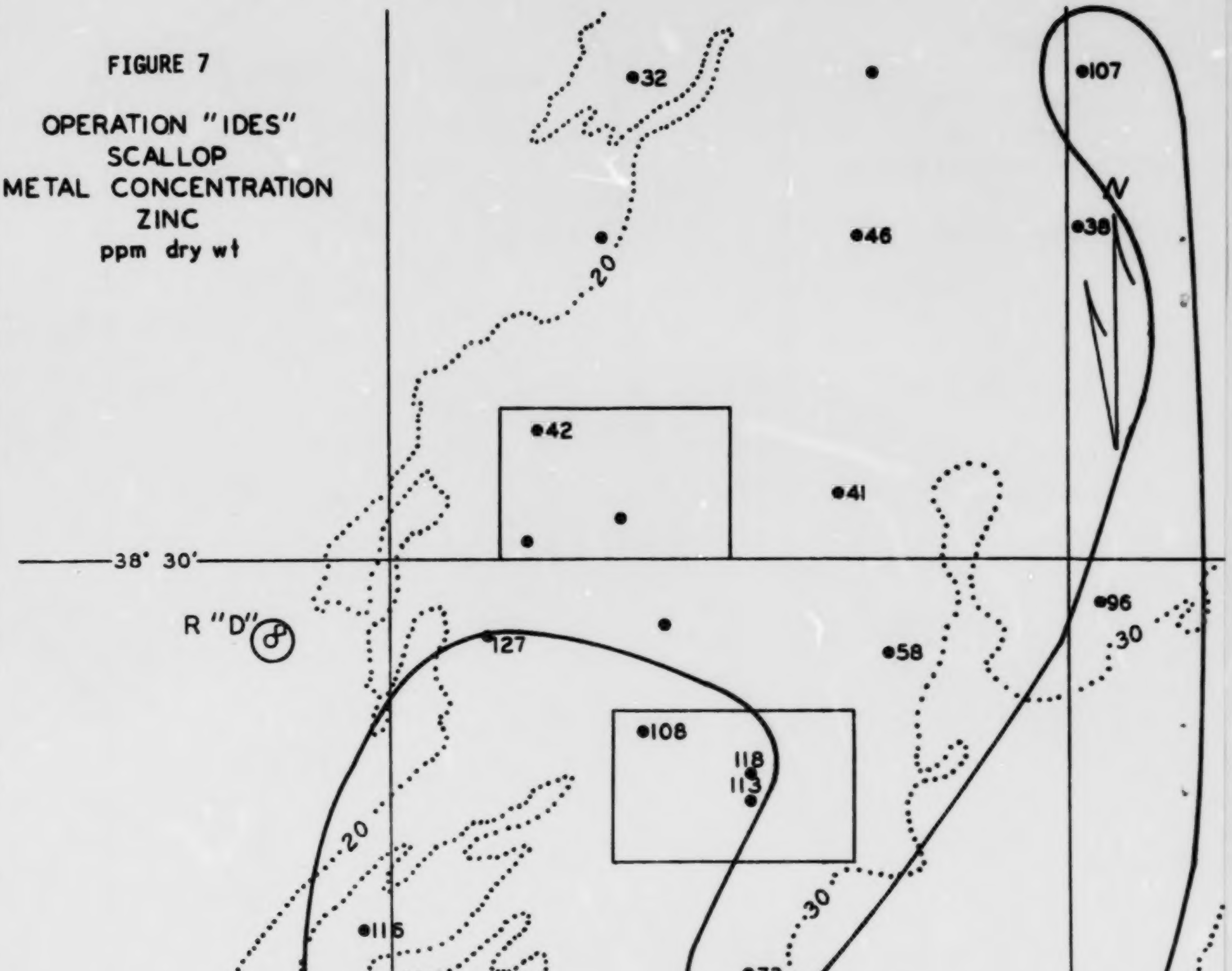
OPERATION "IDES"
ARCTICA
METAL CONCENTRATION
ZINC
ppm dry wt



152.0
107.0
117.0
N
20
128.0
90.5
107.0
38° 30'
R "D"
111.0
92.1
30
89.35
128.0
20
30
114.0
104.0
101.0
88.20
92.0
40
30
40
90.1
100.0
74° 30'
74° 00'
50
38° 00'
20
100

FIGURE 7

OPERATION "IDES"
SCALLOP
METAL CONCENTRATION
ZINC
ppm dry wt


32
46
107
38
42
41
38° 30'
96
R "D"
127
58
108
118
113
116
73
101
99
122
118
53
20
20
20
30
30
30
40
40
50
100
74° 30'
74° 00'
38° 00'

at the time of the "Ides" cruise. DuPont had been dumping for five years. The physical and chemical properties of the two wastes differ considerably. It is unlikely that these wastes would react and behave in a similar manner when dumped.

Analyses of sediments and shellfish show patterns of metal accumulation. Some inferential evidence of impact on shellfish may be obtained by quantifying distribution patterns of dead shell. Figures 8 and 9 represent measures of total dead shell and dead Arctica obtained in half-hour dredge hauls at each station during the "Ides" cruise. Both patterns are associated with accumulated metals from DuPont waste. The results of a DuPont sponsored study are in good agreement with these findings. A survey revealed a "trend toward fewer live sand dollars and higher mortality in areas south of the disposal area than in areas immediately to the west and north . . ." (Myers, 1973). The few selected species, studied in some detail, have been affected by dumping activities. However, the benthic community, studied as a whole, has shown little effect. Community structure indices calculated from results of early cruises, "Quicksilver" and "Fetch", reflect those of unpolluted oceanic waters (Lear, Smith, O'Malley, 1974). Data from later cruises, "Ides" and "Deep Six", are not available. If the benthic community is impacted, it will probably be a long term, chronic effect. The accumulation of nondegradable waste materials may take years to effect noticeable changes in the benthic community structure.

Short-term effects of dumping were the subject of a student cruise conducted by the Marine Science Consortium during August 1973. This group made observations before, during and after dumps of DuPont waste. A reduction in the number of phytoplankton species was the most obvious immediate impact. The numbers were "reduced to 76% immediately upon barge disposal of acid wastes and continued to decrease until it stabilized at approximately 84% of the original assemblage for the duration of the sampling ." (Champ, 1973). Other parameters were considered during this student exercise. This study remains the only published data on short-term effects at either the DuPont or Philadelphia dumpsites.

FIGURE 8

OPERATION "IDES"
DISTRIBUTION OF
DEAD SHELL
(unit = 10 liter buckets)

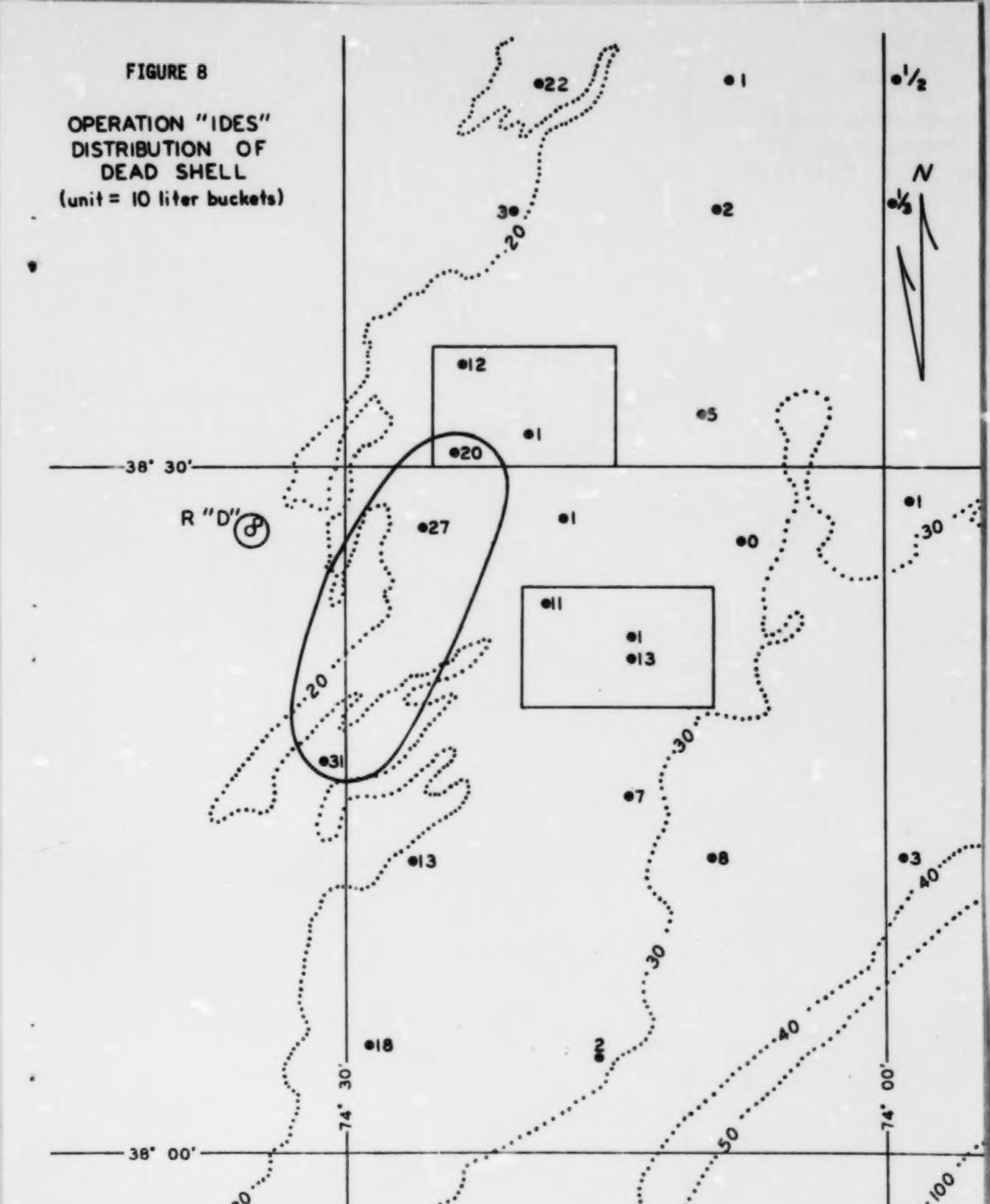
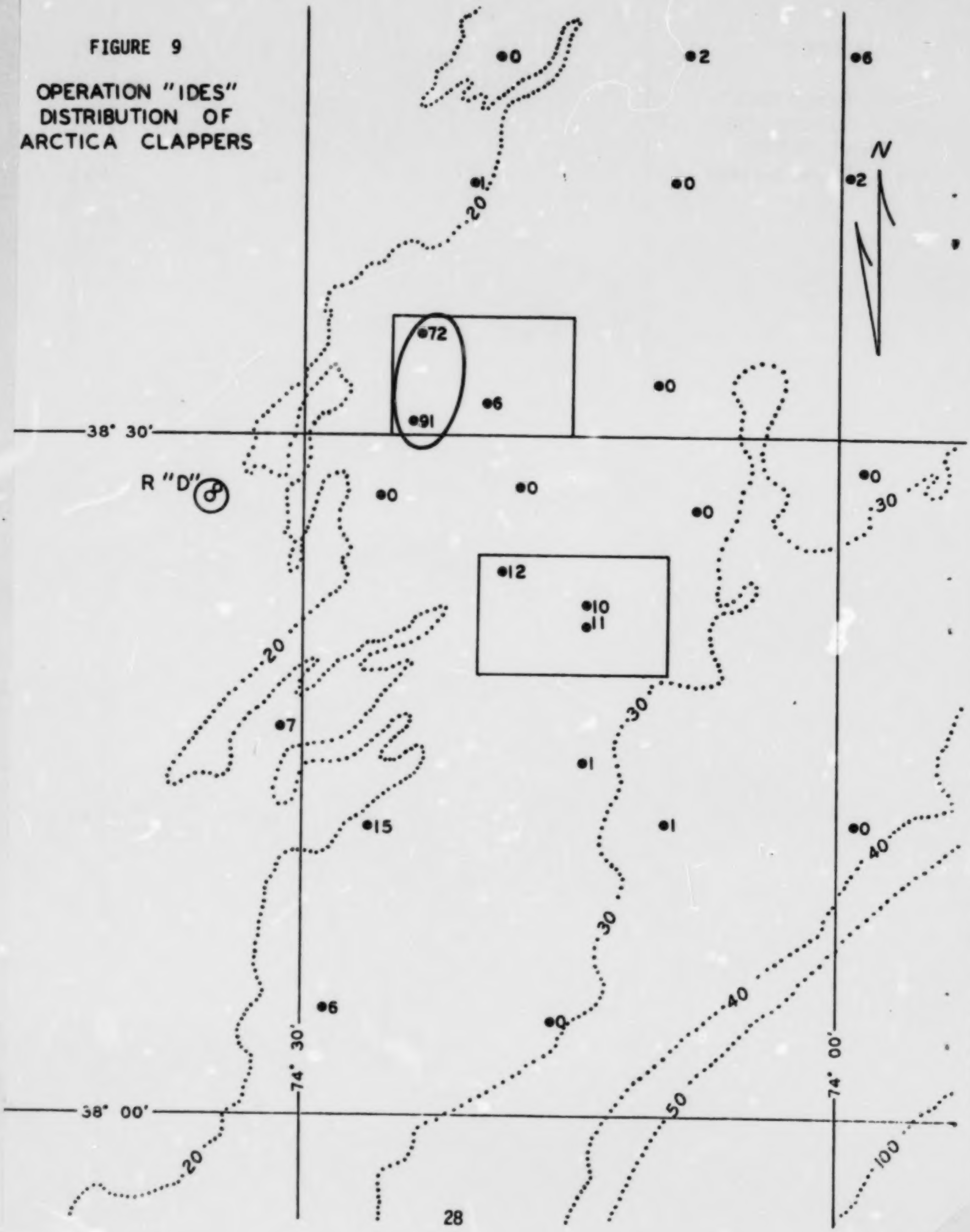

22
1
1/2
N
3
20
2
1/3
12
1
5
20
38° 30'
R "D"
27
1
0
1
30
11
1
13
20
31
30
7
13
8
3
40
30
40
18
2
74° 30'
74° 00'
50
38° 00'
20
100

FIGURE 9

OPERATION "IDES" DISTRIBUTION OF ARCTICA CLAPPERS


N
0
2
6
1
0
2
20
72
0
6
91
38° 30'
R "D"
0
0
0
0
30
12
10
11
20
30
7
1
15
1
0
40
30
40
6
0
74° 30'
74° 00'
38° 00'
50
20
100

APPENDIX A

Operation "Ides"

R/V Advance II - 11-15 March 1974

DATA REPORT

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APPENDIX A

OPERATION "Ides"

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Zooplankton Populations*

Occurrence of Organisms from Trawls*

Metals in Organisms from Trawls*

Metals in Organisms from Rocking Chair Dredge*

Benthic Infauna Populations*

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Ship's Log A-75

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OPERATION "IDES"

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OPERATION "IDES"

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Table 1

OPERATION "IDES"
Station Data
11-15-March 1974

			Loran A				
Station	Date	Time	3H4	3H5	Lat.	Long.	Meters
A	2/11/74	0800	3512	3065	38°42.0'	74°20.0	35
C	"	1145	3420	3043	38°31.5'	74°20.0'	44
B	"	1535	3395	3053	38°31.0'	74°23.9'	36
D	"	1745	3401	3030	38°28.5'	74°17.2'	31
2	"	2039	3356	3009	38°21.9'	74°12.7	54
8	3/12/74	0045	3361	3008	38°22.5'	74°12.5'	46
9	"	0418	3217	3057	38°18.3'	74°33.7'	42
17	"	0735	3181	3030	38°10.5'	74°29.5'	49
36	"	0936	3110	3017	38°05.0'	74°28.2'	42
27	"	1417	3182	2974	38°05.0'	74°13.9'	57
F	"	1700	3300	2974	38°13.7'	74°08.1'	68
24	"	2055	3305	2998	38°17.4'	74°13.9'	54
25	"	2345	3345	2937	38°12.7'	73°58.4'	75
14	3/13/73	0515	3500	2968	38°28.9'	73°58.6'	53
19	"	1028	3610	2997	38°40.5'	74°00.1'	53
30	"	1755	3680	3010	38°47.4'	73°59.8'	46
29	"	1950	3630	3047	38°48.0'	74°09.5'	46
28	"	2237	3580	3078	38°47.6'	74°19.2'	40
18	3/14/74	0420	3550	3032	38°40.3'	74°10.1'	44
21	"	0545	3490	3009	38°33.7'	74°07.8'	46

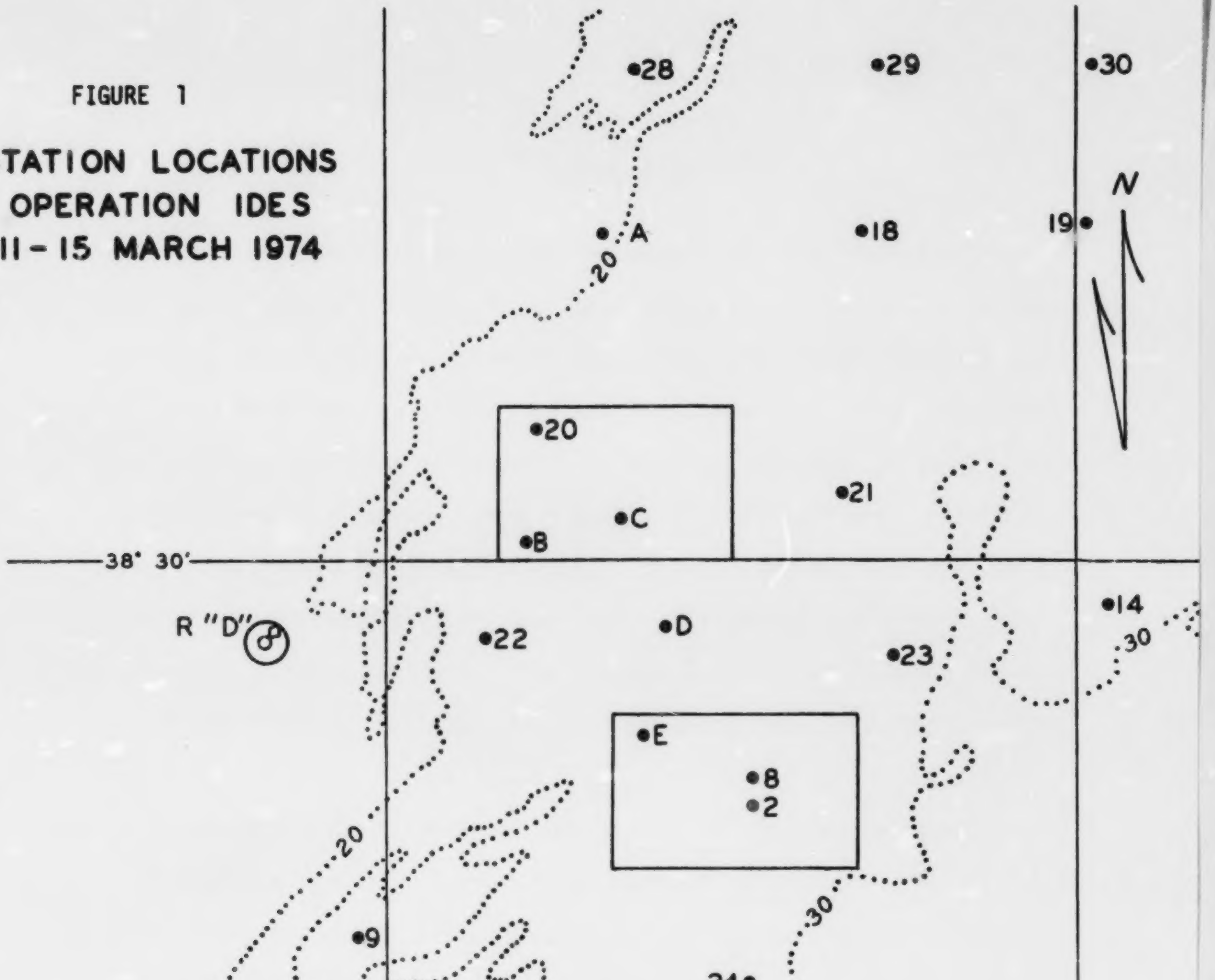
OPERATION "IDES"

Station Data (continued)

			Loran A				
Station	Date	Time	3H4	3H5	Lat.	Long.	Meters
23	3/14/74	0815	3445	2998	38°27.7'	74°18.7'	58
20	"	1930	3430	3060	38°34.0'	74°22.8'	42
22	"	1115	3345	3053	38°26.9'	74°26.2'	48
E	3/15/74	0037	3351	3025	38°24.0'	74°18.6'	42

FIGURE 1

STATION LOCATIONS
OPERATION IDES
11-15 MARCH 1974



N
28
29
30
A
18
19
20
20
C
B
21
38° 30'
R "D"
22
D
23
14
30
E
8
2
20
30
9
24
17
F
25
40
30
40
26
27
74° 30'
74° 00'
50
38° 00'
20
100

OPERATION "IDES"

HYDROGRAPHY

The distribution of temperature and salinity during this early spring cruise indicate that the onset of the annual thermocline had not yet come about. The surface layers down to 15 meters were generally isothermal and characteristic of the shelf water at that season.

There is, however, evidence of a warm water intrusion from the southeast. The intrusions have been reported before (Harrison, Norcross, Pore, and Stanley, 1967; Myers, 1973). This area is apparently a region that is affected, not only by incursion of less saline estuarine water in the surface from the westward but warm water intrusions of slope water origin are noted intruding from the southeast in this instance (Figure 2).

Observations published by the U.S. Navy (Gulf Stream Reports, Vol 9, 1974) indicate Gulf Stream eddies were active just offshore of this area during this season. It is difficult to determine, with any degree of certainty, whether any of these eddies may have had some affect on this distribution of temperature and salinity.

Surface and bottom current meters were maintained for 96 hours on two stations during this cruise. A malfunctioning meter on the bottom at one station precluded good observations at that station; however, Station 2, at the surface and the bottom, indicate during this period that the prevailing currents were headed towards the southeast at the surface at Station 2 and towards the northeast at the bottom at Sta. 2 during this period (Figures 4 and 5). These observations would appear to be in contradiction to the net movement observed by the seabed drifter releases reported in the earlier report (Palmer and Lear, 1973). The current observations, however, are of short term and apparently reflect the tidal currents under the particular climatic regime.

The current velocities at the bottom at Station 2 indicate that velocities are attained in this region about 16.8 percent of the time which are capable of transport of the bottom materials at this station. This would indicate that the materials settling to the bottom are subjected to scouring action and translocation.

OPERATION "IDES"

BT Data

Temperature Degrees C°

Station		14	19	30	23	F	9	8	C	22	28
Depth											
Ft	M										
0	0	7.2	7.0	7.35	8.40	9.50	7.0	8.55	8.20	7.10	6.5
10	3.0						7.20				
20	6.1						7.40				
30	9.1						7.60	8.60			
40	12.2					9.55	9.30	8.70			
50	15.2						9.30	8.80			
60	18.3						9.35	8.75			
70	21.3							8.65			
80	24.4										
85	25.9										
90	27.4	7.30				9.60			8.25		
95	29.0	7.35									
100	30.5	7.35				9.70		9.70			
105	32.0	7.35						10.05	10.0		
110	33.5		7.10			10.40					
115	35.0		7.15								
120	36.6		7.20			10.65					
125	38.1		7.25								
130	39.6		7.30		8.40						
135	41.2		7.35								
140	42.7		7.50		8.55						

OPERATION "IDES"

BT Data (continued)

Temperature Degrees C°

Station		14	19	30	23	F	9	8	C	22	28
Depth Ft	M										
145	44.2		7.55								
150	45.7		7.60		8.65	10.70		10.10			
155	47.3		7.70								
160	48.8				8.80						
165	50.3										
170	51.8										
175	53.4										
180	54.9										
185	56.4					10.75					
190	57.9										
195	59.5										
200	61.0										

OPERATION "IDES"

SALINITY ANALYSES

R. J. Callaway
EPA Pacific Northwest Research Laboratory
Corvallis, Oregon

The results of salinity analysis of "Ides" samples received from the Annapolis Field Office are reported to 0.01 part per thousand (°/₀₀). Many of the samples were not sufficiently large to provide a sample cell rinse prior to analysis. Over the range analyzed 31.00°/₀₀ to 35.00°/₀₀, this could cause an error of as much as 0.04°/₀₀. Most of the samples, however, varied by only 1.00°/₀₀ which would cause an error of 0.01°/₀₀.

Samples for which results were judged anomalous were reanalyzed, size of sample permitting. These values are reported in the summary. The greatest difference was 0.02°/₀₀ from the original analysis.

Instrument drift over the period of analysis was less than 0.01°/₀₀. The samples were analyzed on a Hytech 6220.

Table 3

OPERATION "IDES"
SALINITY
(°/oo)

Location	Depth (meters)	Salinity	Remarks
Sta. 2	1	34.46	
	18	34.45	
	36	34.99	
	50	34.84	
Sta. 8	4	34.25	
	23	34.28	
	30.5	35.09	
	46		
Sta. 9	5	33.28	
	15.5	32.95	Reanalyzed value = 32.94
	23	33.91	
	31	31.08	Reanalyzed value = 31.10
Sta. 14	2	34.51	Values rechecked; not enough sample for reanalysis
	19	33.26	" " " "
	35	34.40	Reanalyzed value = 34.41
	51	34.35	
Sta. 19	3	33.47	Reanalyzed value = 33.41
	23	33.40	
	30.5	33.39	
	55	33.58	

SALINITY (continued)
(°/₀₀)

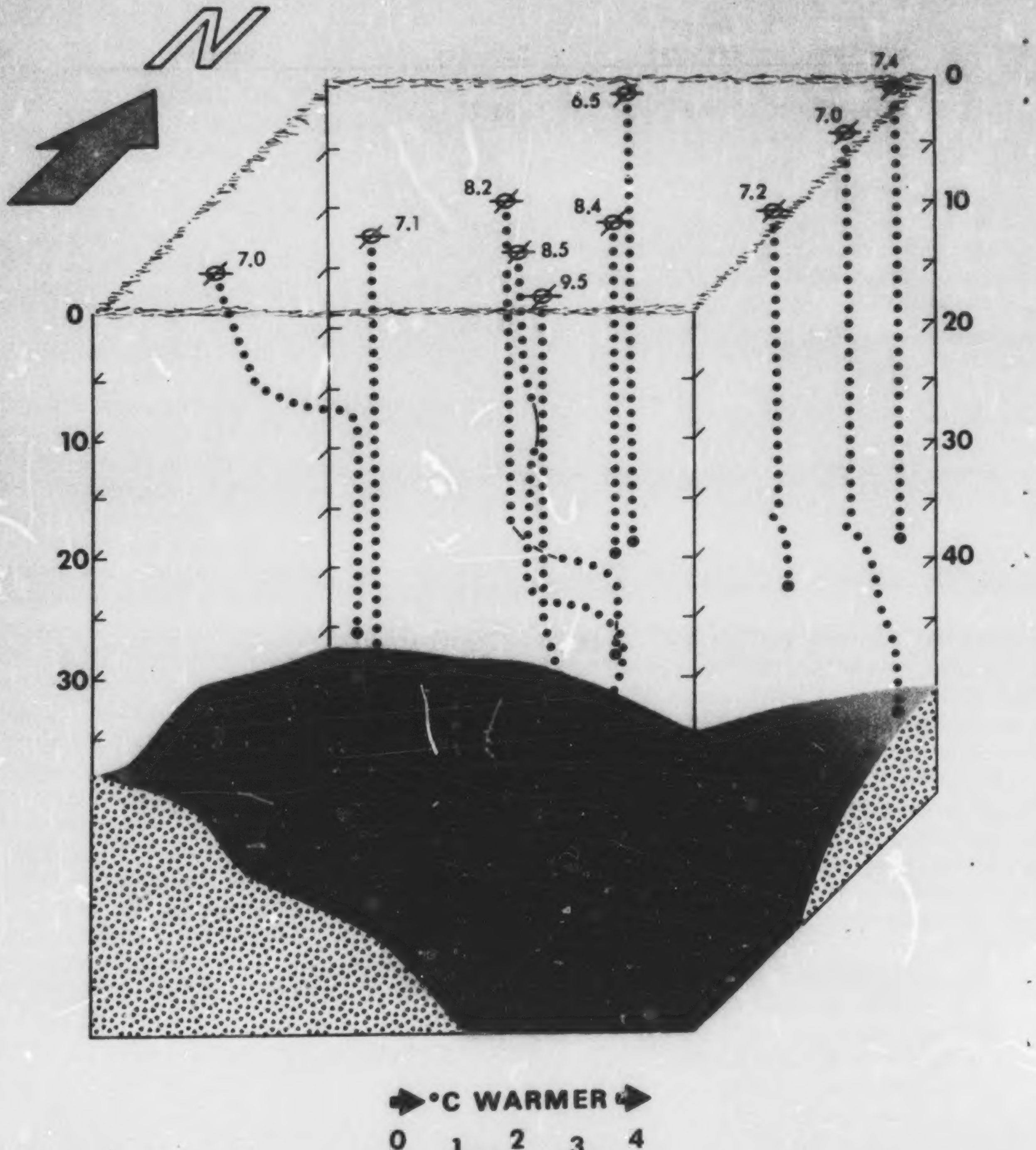
Location	Depth (meters)	Salinity	Remarks
Sta. 22	1	33.39	
	10	33.48	
	20	33.53	
	35	34.20	
Sta. 26	1	34.08	Value checked; insufficient sample for reanalysis
	16	33.96	
	32	33.91	
	40	33.91	
Sta. 28	1	33.35	
	21	33.15	Reanalyzed value = 33.14
	30.5	33.37	
	42	33.44	Duplicate analysis value = 33.45
Sta. 30	1	34.05	Value checked; insufficient sample for reanalysis
	15	33.96	" " "
	30	33.74	" " "
	45	33.82	" " "
Sta. C	6.1	33.94	
	22.9	33.99	
	30.5	34.07	
	42.7	34.20	

SALINITY (continued)
(°/₀₀)

Location	Depth (meters)	Salinity	Remarks
Sta. E	2	33.71	
Sta. F	12	34.25	
	22	34.25	
	37	34.26	
	67	34.60	

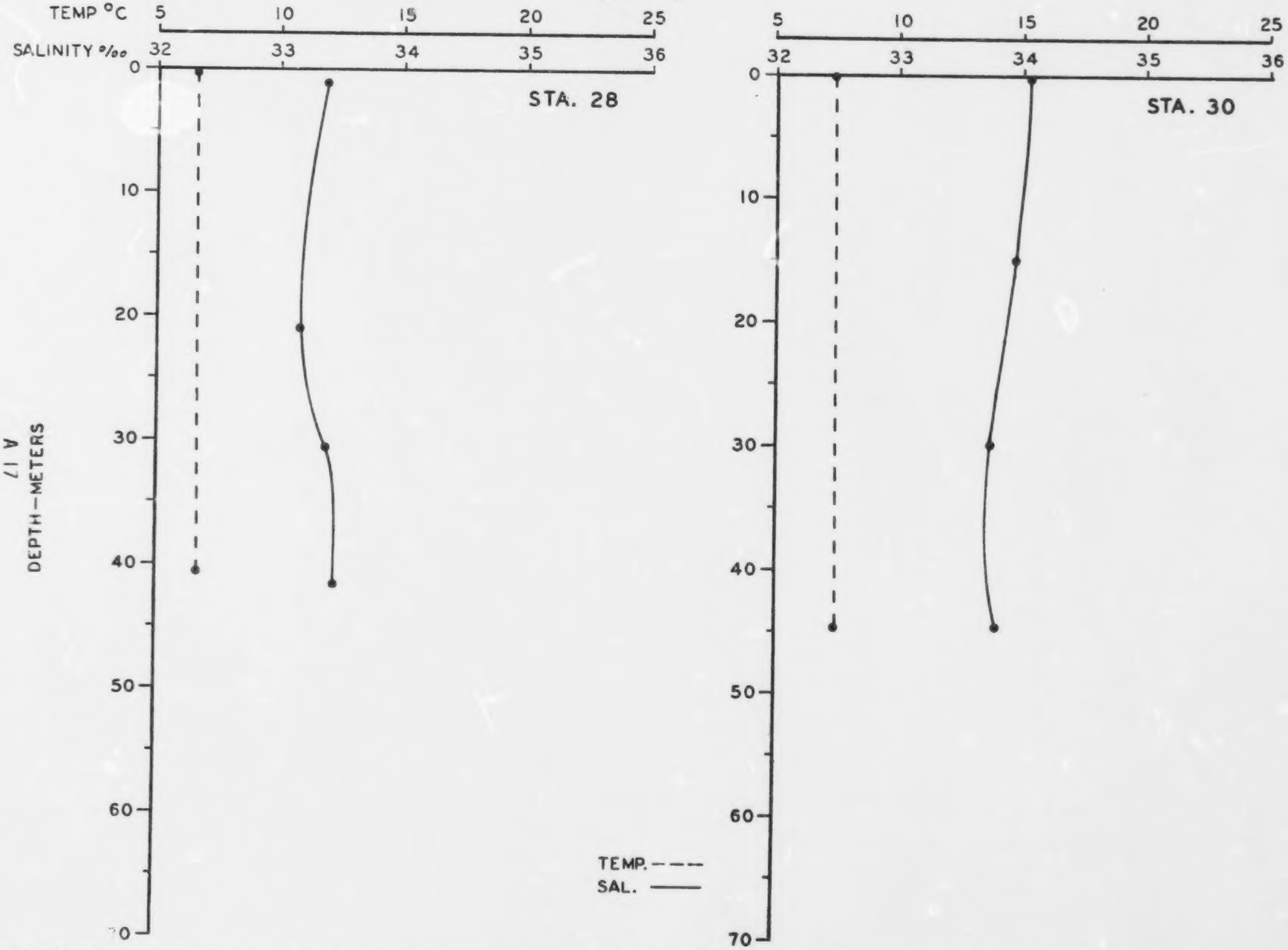
FIGURE 2

TEMPERATURE DISTRIBUTION MARCH 1974


N
7.4
0
6.5
7.0
8.2
7.1
10
7.2
8.4
8.5
7.0
9.5
0
20
10
30
40
20
30
°C WARMER
0
1
2
3
4

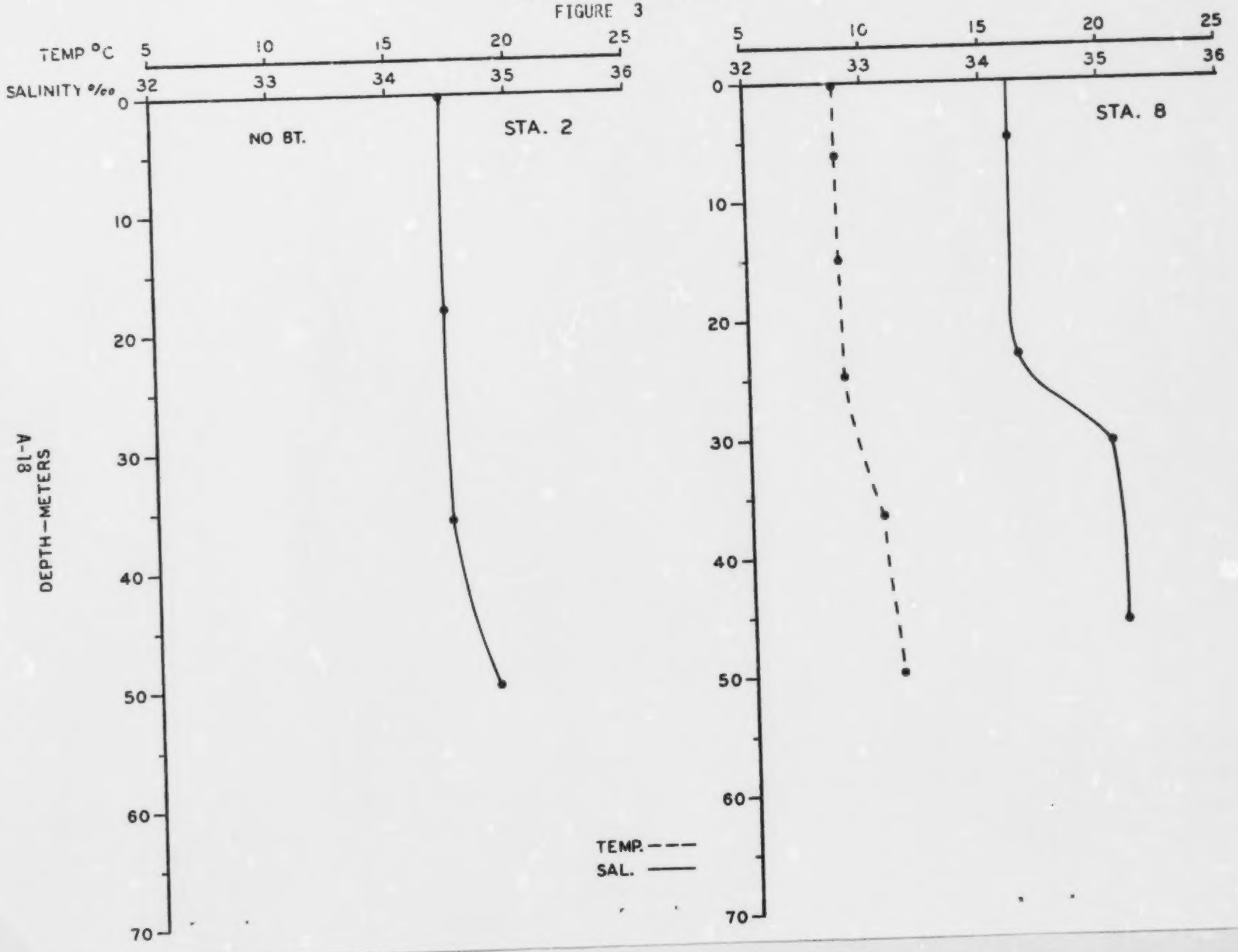
TEMPERATURE - SALINITY PROFILES
OPERATION IDES

FIGURE 3



TEMPERATURE-SALINITY PROFILES
OPERATION ICES

FIGURE 3



TEMPERATURE - SALINITY PROFILES
OPERATION IDES

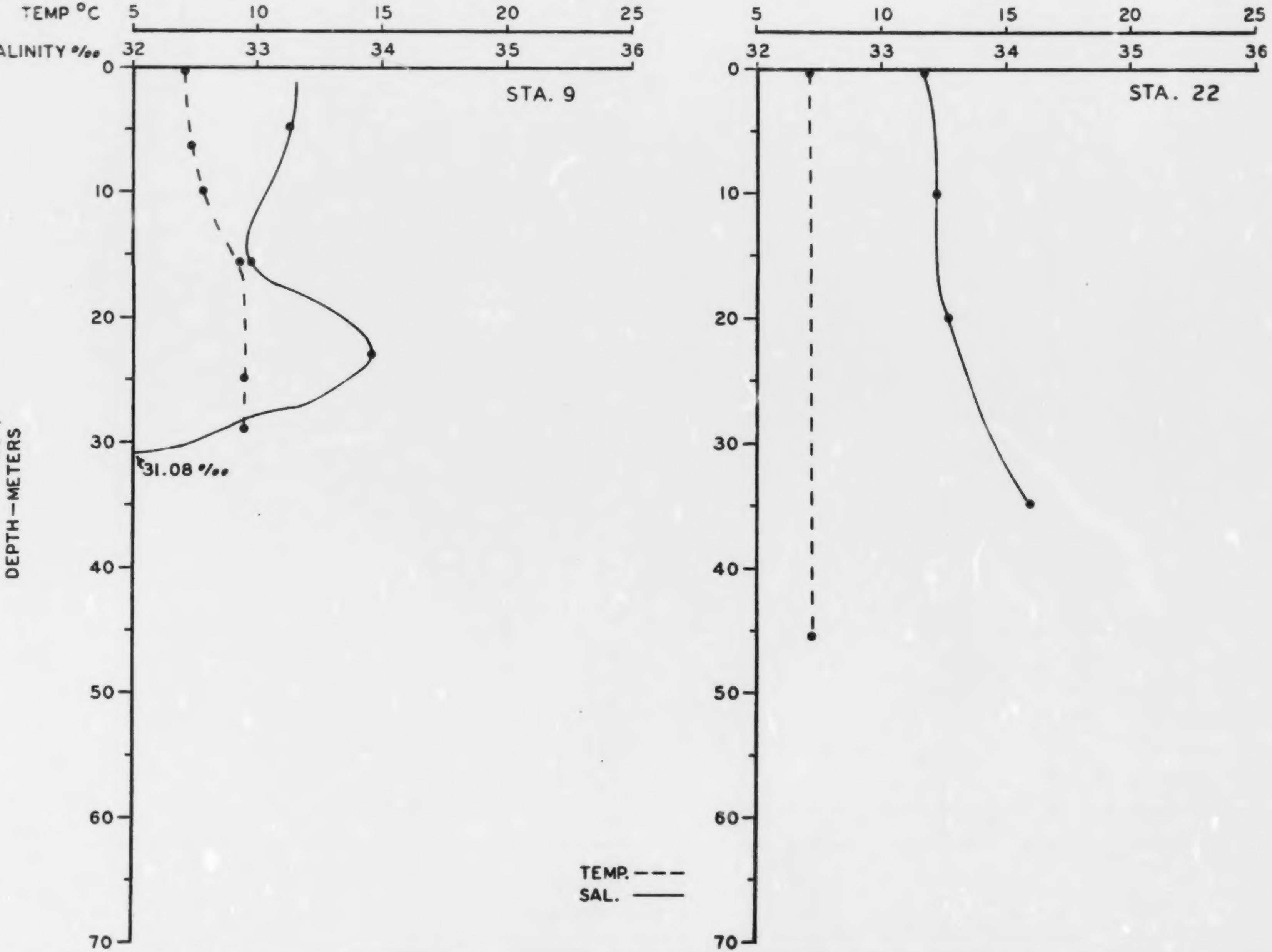
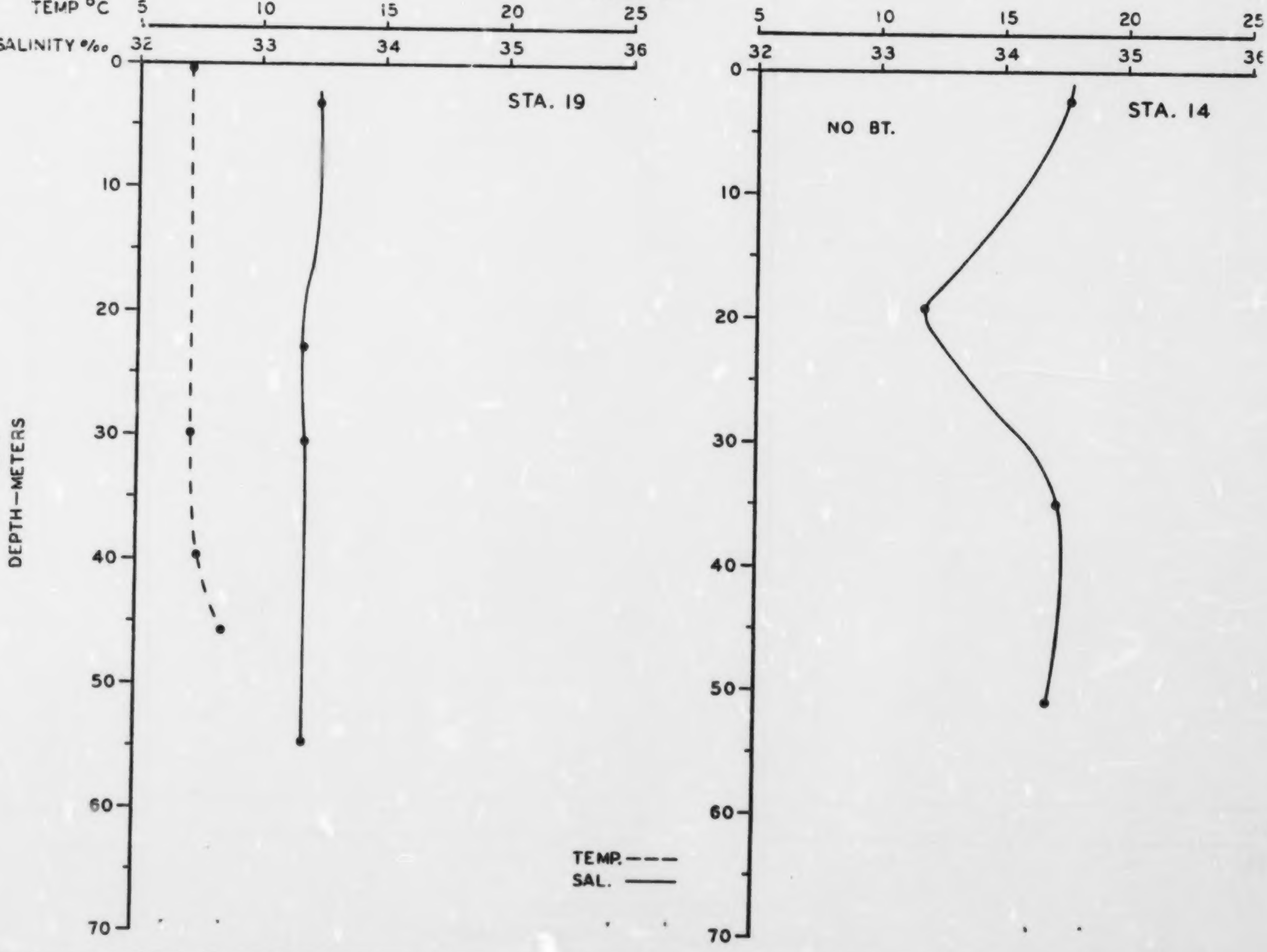


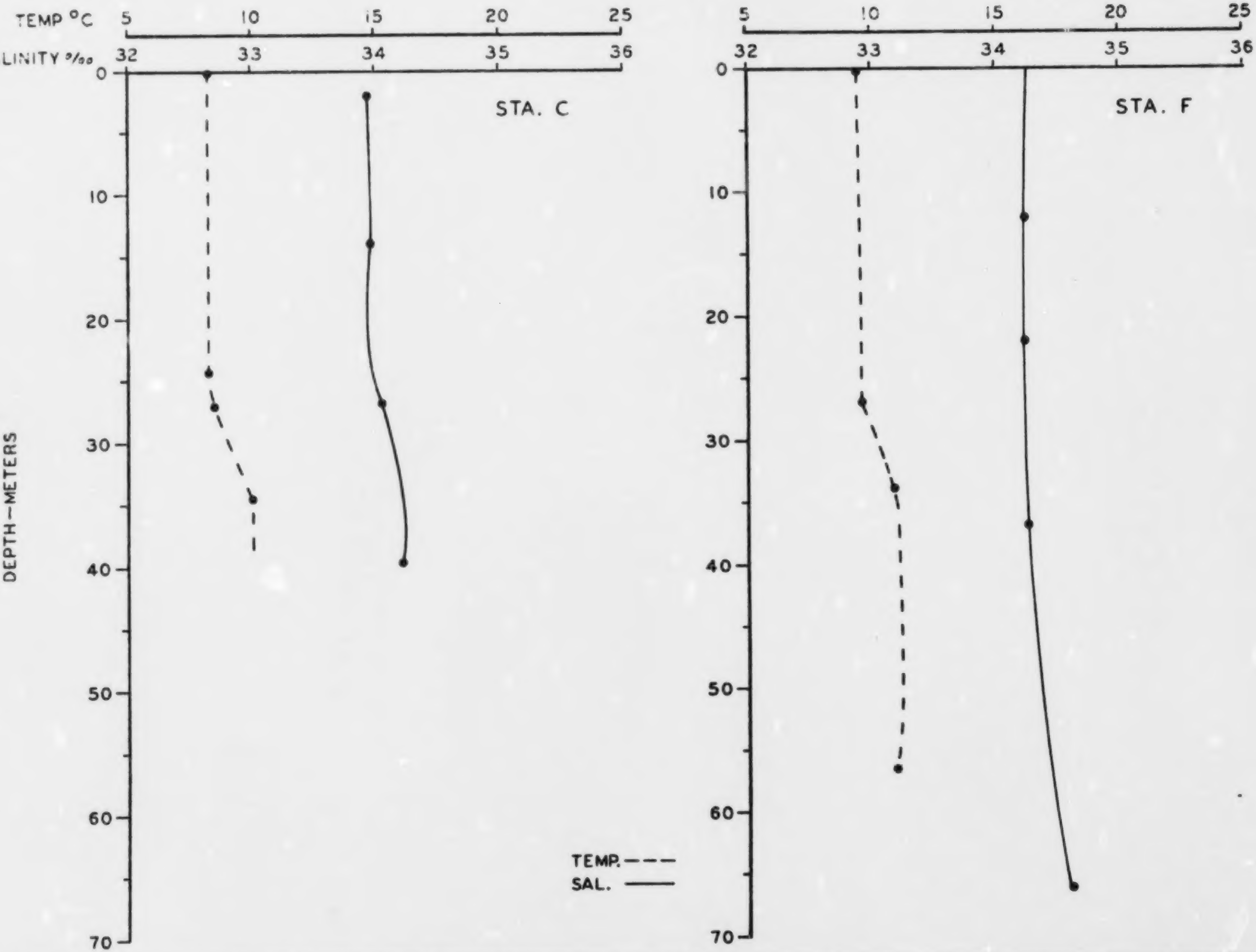
FIGURE 3

TEMPERATURE-SALINITY PROFILES
OPERATION IDES

FIGURE 3



TEMPERATURE--SALINITY PROFILES
OPERATION IDES



TEMPERATURE-SALINITY PROFILES
OPERATION IDES

FIGURE 3

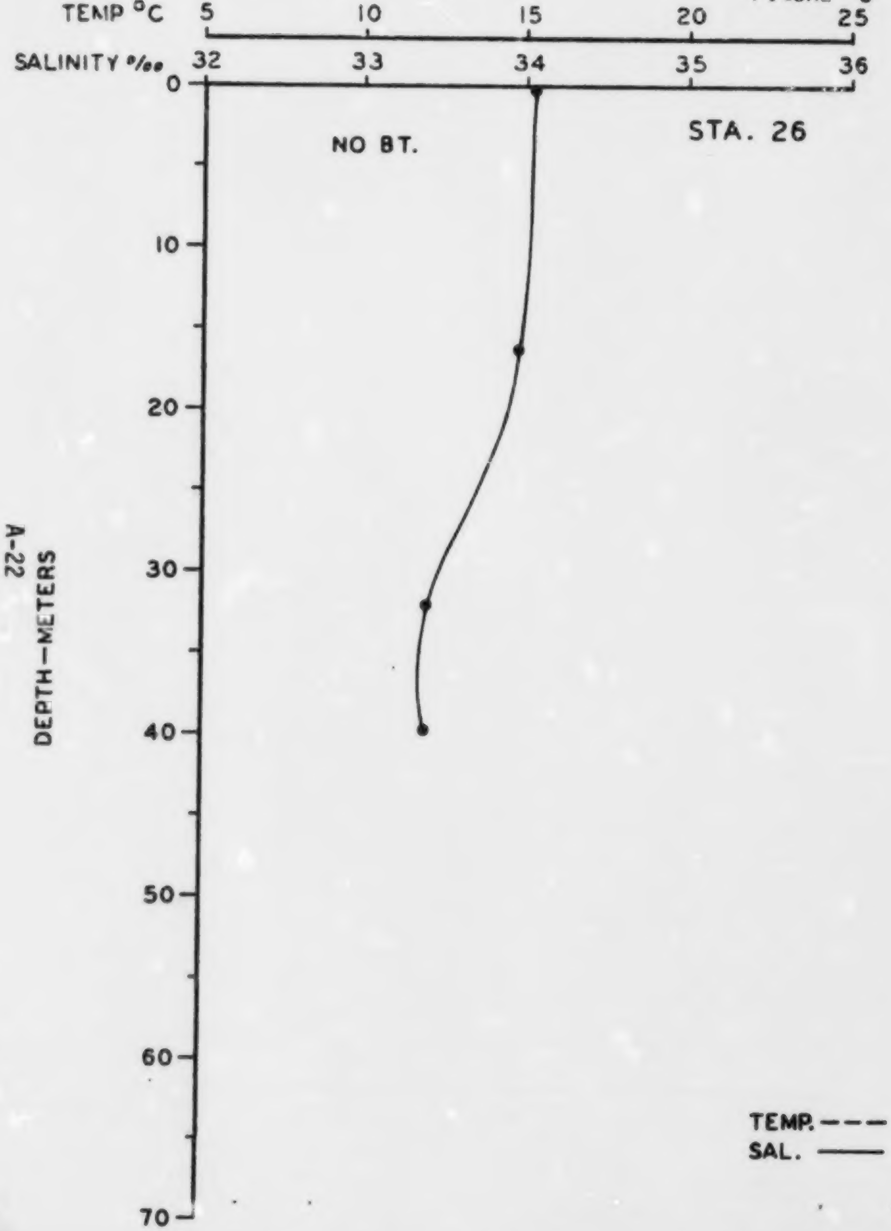
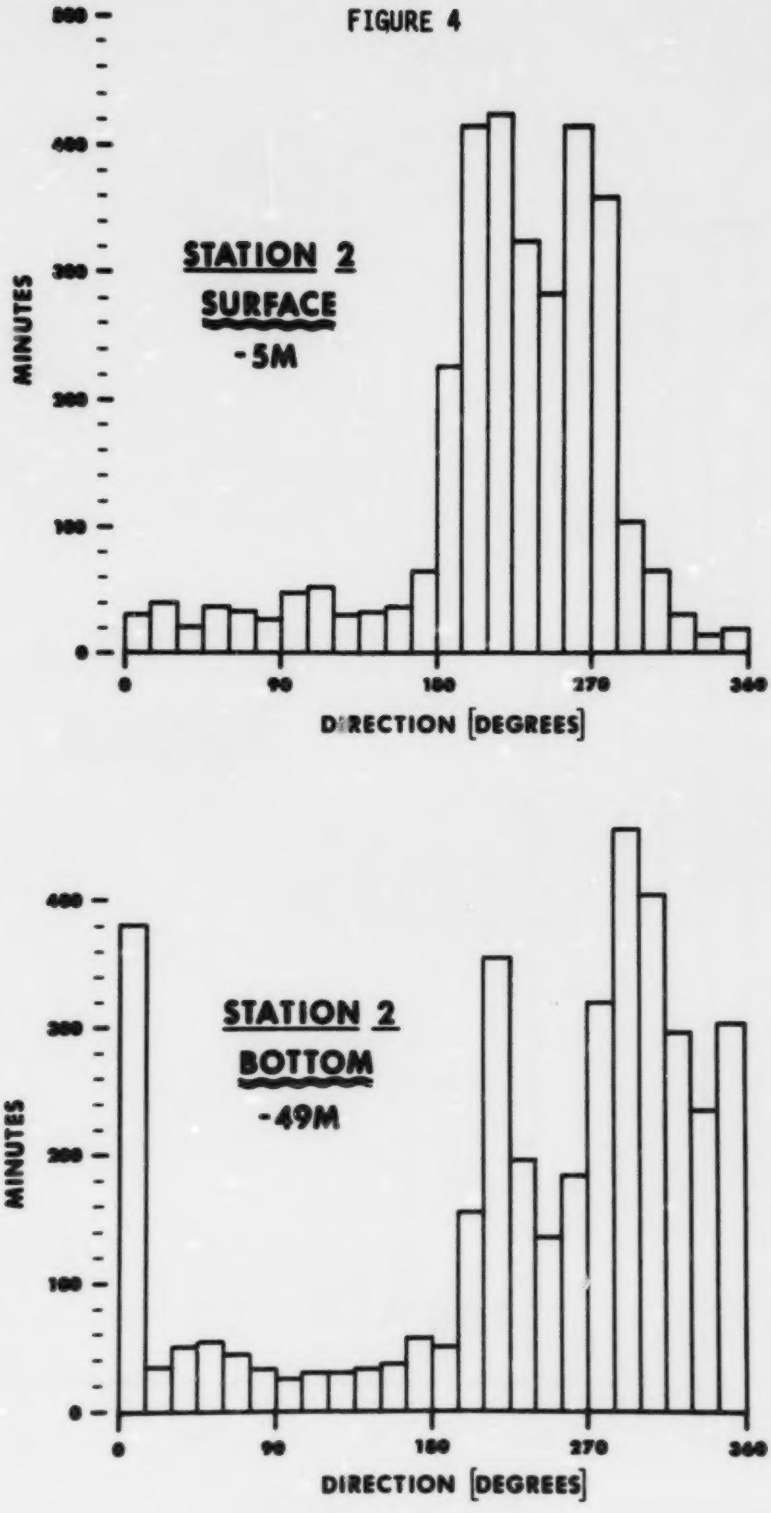


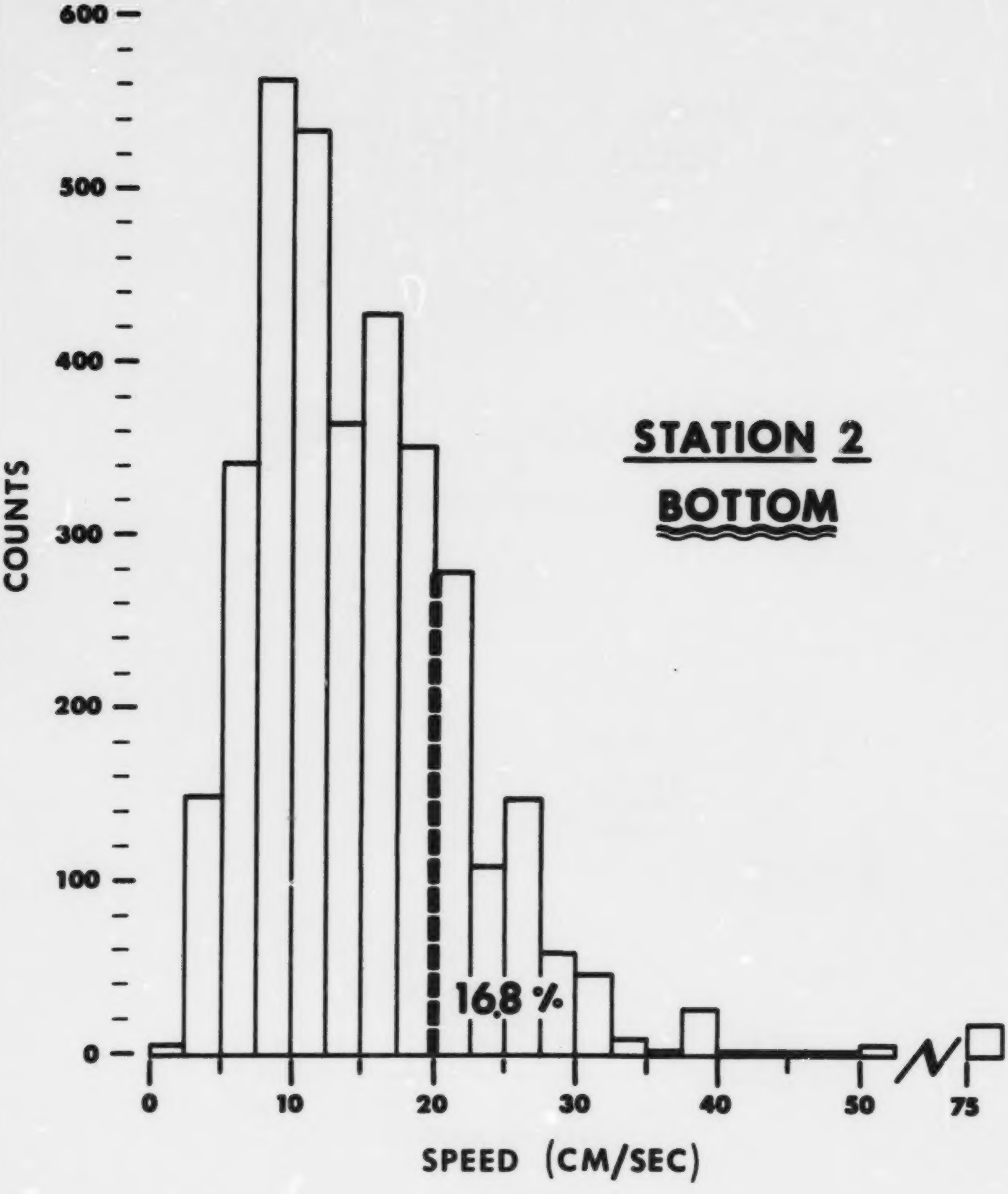
FIGURE 4



SHORE CURRENTS

MARCH 1974 - DEPTH 54M

FIGURE 5


STATION 2
BOTTOM
COUNTS
600
500
400
300
200
100
0
16.8 %
0
10
20
30
40
50
75
SPEED (CM/SEC)

OPERATION "IDES"

WATER QUALITY PARAMETERS

The distribution of phosphorus and nitrogen compounds in the water column at this season indicate no obvious buildup of these materials in any area (Figures 6 and 7).

The total carbon and total organic carbon would appear to be comparable in dumping areas and reference areas in the water column. Bacteriological results indicate no buildup of coliforms or fecal coliforms in the water or sediments examined.

Table 4

OPERATION "IDES"

Water Quality Parameters

Station	Date	Time	Depth (meters)	Total P PO_4(mg/l)	Inorg. P PO_4(mg/l)	TKN (mg/l)	NO_2+NO_3 (mg/l) NO_3-N	TC (mg/l)	TOC (mg/l)
2	3-11-74	2130	1	.056	.032	.210	<0.10		
			18	.038	.035	.207	↑		
			36	.057	.052	.187			
			50	.047	.037	.207		37.75	7.70
8	3-12-74	0045	4	.065	.035	.207			
			23	.060	.031	.175			
			30.5	.058	.049	.226			
			46	.065	.029	.220		29.80	7.20
9	3-12-74	0412	5	.075	.032	.175			
			15.5	.077	.024	.220			
			23	.064	.032	.207			
			31	.061	.041	.149		31.65	7.20
14	3-13-74	0515	2	.053	.027	.162			
			19	.060	.031	.194			
			35	.062	.027	.200			
			51	.061	.040	.168		31.00	7.50
19	3-13-74	1028	3	.064	.035	.155			
			23	.061	.032	.155			
			30.5	.056	.037	.168	↓		
			55	.058	.041	.168	<0.10	28.85	6.44

OPERATION "IDES"

Water Quality Parameters

Station	Date	Time	Depth (meters)	Total P PO_4(mg/l)	Inorg. P PO_4(mg/l)	TKN (mg/l)	NO_2+NO_3 (mg/l) NO_3-N	TC (mg/l)	TOC (mg/l)
22	3-14-74	1115	1	.072	.037	.265	<0.10		
			10	.064	.041	.246	↑		
			20	.061	.029	.175			
			35	.066	.041	.226		34.55	5.88
26	3-12-74	0936	1	.039	.036	.226			
			16	.054	.032	.246			
			32	.049	.045	.246			
			40	.046	.046	.252		31.10	7.55
28	3-12-74	2237	1	.065	.029	.220			
			21	.091	.032	.239			
			30.5	.068	.034	.230			
			42	.056	.041	.317		28.55	6.71
30	3-13-74	1540	1	.062	.037	.323			
			15	.062	.045	.213			
			30	.057	.035	.233	↓		
			45	.065	.033	.239	<0.10	29.50	6.71

FIGURE 6

DISTRIBUTION OF TOTAL KJELDAHL NITROGEN µgm/l
OPERATION IDES

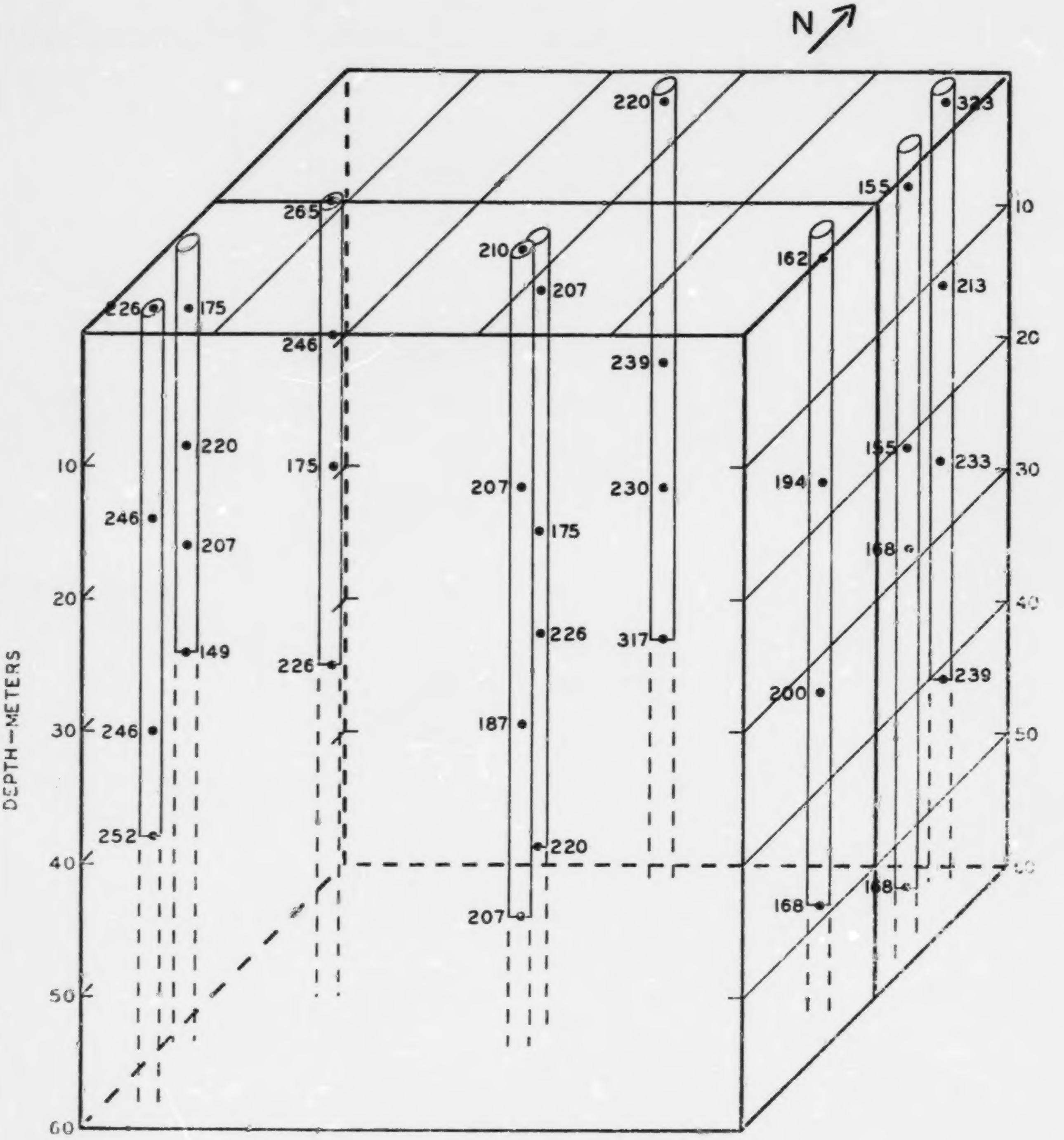
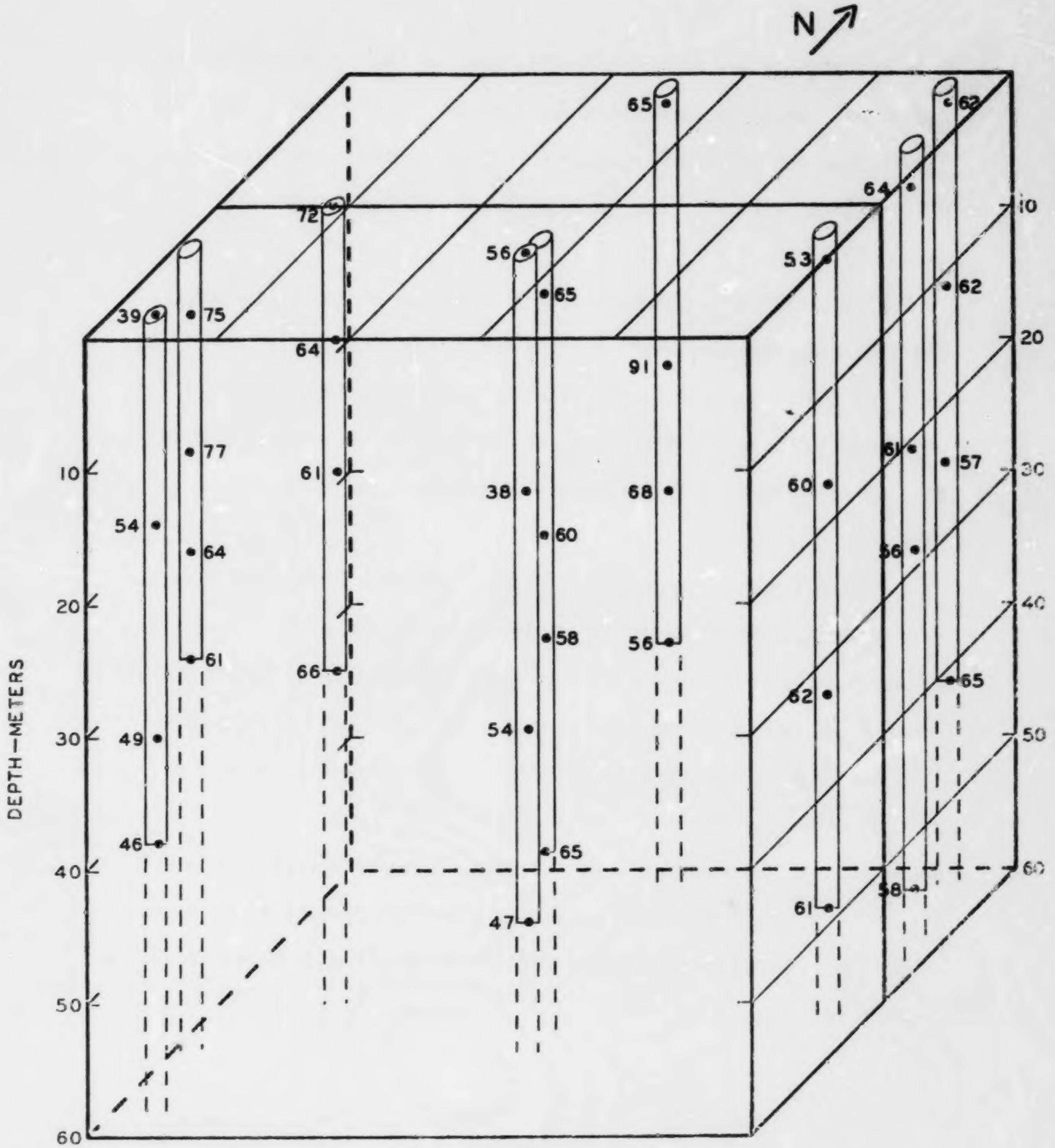

N
DEPTH—METERS
10
20
30
40
50
60
226
175
265
246
210
207
220
239
230
317
155
323
162
213
155
233
194
168
200
239
168
168
220
207
246
246
252
149
175
226
207
175
226
187
220
207
10
20
30
40
50
60

FIGURE 7

DISTRIBUTION OF TOTAL PHOSPHORUS μgm/l
OPERATION IDES


N
DEPTH-METERS
10
20
30
40
50
60
10
20
30
40
50
60
39
75
72
64
56
65
65
91
53
64
62
62
77
54
64
61
61
38
60
68
60
61
57
56
58
56
54
49
66
54
65
62
65
46
61
47
58
61

OPERATION "IDES"

BACTERIOLOGY

M. O'Malley and S. K. Smith

Two studies are reported for the area of the two interim ocean dumpsites. Baseline conditions are recorded in a report by EPA, Region III (Palmer and Lear, 1973) while conditions after municipal sludge dumping began are described in a second report for EPA, Region (Lear, et al, 1974).

Nine stations for bacteriological analyses of the bottom waters and sediments were occupied in the interim dumpsites areas. Stations 2, 8 and E were located in the site for municipal sludge disposal while Station C was in the center of the acid waste site. The remaining five stations were control stations located outside of the two disposal sites.

A Niskin sterile bag sample (General Oceanics, Inc.) was used to take water samples from varying depths at 1.5 m above the bottom. A 2.7 ml flame-sterilized cylindrical spoon was used to subsample sediments from an undisturbed Shipek bottom grab. This aliquot was introduced into a French square containing 100 ml sterile distilled water and treated as a normal bacteriological sample.

Water and sediment samples were subjected to the standard total coliform and fecal coliform MPN (most probable number/100 ml sample) analyses as outlined in "Standard Methods for the Examination of Water and Wastewater," 13th Ed., SPHA, 1971.

Using sample aliquots of 10.0, 1.0, 0.1, and 0.01 ml, a 3-tube, 4-dilution scheme was followed.

Negative MPN results were recorded for both total coliforms and fecal coliforms at all stations. A negative result indicates an MPN index of less than three coliforms or fecal coliforms per 100 ml of sample at the 95% confidence limit. Laboratory controls were also negative for both coliforms and fecal coliforms.

Table 5

OPERATION "IDES"

Bacteriological Stations

Station	Date	Time	Depth (m)	Sample
2	3-11-74	2039	53.9	Water
				Sediment
8	3-12-74	0330	45.7	Water
				Sediment
9	3-12-74	0550	42.0	Water
				Sediment
14	3-13-74	0515	53.0	Water - LA*
				Sediment
19	3-13-74	1028	53.0	Water
				Sediment
22	3-14-74	3053	47.5	Water
				Sediment - LA*
26	3-12-74	0936	42.0	Water
				Sediment
C	3-11-74	1145	43.9	Water
				Sediment
E	3-15-74	0230	42.0	Water
				Sediment

All samples were negative for coliform and fecal coliforms

*LA - Lab Accident, no analysis

OPERATION "IDES"

SEDIMENTS

Particle size analyses, using a sieve series, indicate these sediments in nearly all the areas are coarse to fine sands with no appreciable silt or clay fractions present. Visual observations by use of the two-man submersible, as reported in Appendix C, indicate there is much broken shell, and in some areas gravel on the bottom as well.

At Station C in the acid waste release site, the rocking chair dredge came up with a varied assemblage of apparently wave-worn cobbles. These are illustrated in Figures 8, 9, 10, and 11, courtesy of Dr. Harold D. Palmer, Westinghouse Ocean Research Laboratory, Annapolis, Maryland. These cobbles may indicate the locus of an interglacial still-stand (Swift, et al, 1972). If these cobbles are available to the dredge, which would dig a maximum of 18 inches, would indicate that this area is not depositional in character, and that relatively little sediment has accrued here since glacial epochs.

Among the cobbles are some large oyster shells. These characteristically estuarine animals are not currently found in this area and are presumably fossil shells from this earlier geological period. Shells have been submitted for radiocarbon dating. This area is also overlying the buried Delaware River Valley and may have a relationship with the relict estuary.

Organic carbon concentrations in these sediments indicate no obvious buildup of this material (Table 7, Figure 13).

Table 6

OPERATION "IDES"

Sediment Size Fractions
Weight Percent

Station	Dry wt. gm	Phi -1.0 mm -2.0	0.0 1.0	1.0 0.5	2.0 0.25	3.0 0.125	4.0 0.062	Median Phi
2	26.09	15.57	1.43	3.99	10.48	63.23	3.32	2.26
	16.87	3.91	0.41	0.88	11.49	78.54	3.73	2.45
	21.16	0.00	0.18	0.51	9.73	84.68	4.01	2.45
	35.52	0.87	0.14	0.87	9.68	82.74	5.01	2.50
	37.89	0.26	0.07	0.34	8.57	85.80	4.59	2.50
8	26.65	2.66	11.78	19.10	30.43	32.87	2.55	1.54
	25.32	0.18	0.79	8.33	10.07	73.54	5.88	2.65
	41.67	1.65	1.00	6.64	8.63	75.59	5.75	2.65
	28.41	2.46	15.06	32.17	40.80	8.97	0.63	1.05
	54.34	3.25	1.25	7.74	11.75	70.15	3.95	2.55
9	28.78	4.55	7.22	26.16	46.14	14.38	0.69	1.28
	32.00	0.25	2.12	19.62	58.43	18.65	0.10	1.45
	24.33	3.78	4.27	26.34	52.24	12.04	0.69	1.30
14	22.30	1.79	1.61	11.30	64.22	20.00	0.17	1.55
17	30.00	0.56	0.36	4.27	67.50	25.73	1.26	2.39
18	24.27	1.97	0.74	1.94	21.63	69.72	3.62	2.34
19	25.40	0.94	0.15	0.28	10.20	83.23	1.85	2.46
	27.07	0.44	0.11	0.48	17.73	80.12	2.36	2.40
20	25.21	0.00	0.00	-	1.62	77.31	13.53	2.64
21	30.33	0.03	0.46	1.88	67.46	25.16	0.09	1.70
22	24.86	0.20	0.28	0.92	12.39	70.92	14.16	2.51
	41.65	40.76	10.46	14.06	8.30	20.04	5.47	0.00
23	30.43	27.83	9.86	16.10	27.08	17.12	1.18	0.76
24	9.32	0.00	3.00	7.08	19.74	45.39	12.87	2.44
	30.02	7.02	11.55	36.34	38.64	6.96	0.13	0.86
25	25.05	1.84	2.24	10.78	54.73	33.09	0.44	1.65
26	27.48	3.89	1.56	13.94	57.75	22.56	0.43	1.51
	32.20	2.36	2.57	14.34	60.83	19.03	0.40	1.50
	45.54	2.74	2.02	15.17	62.56	17.14	0.24	1.50
	36.20	1.02	1.83	17.34	63.48	15.93	0.24	1.50
	27.62	1.33	1.33	14.40	62.03	19.29	0.39	1.50

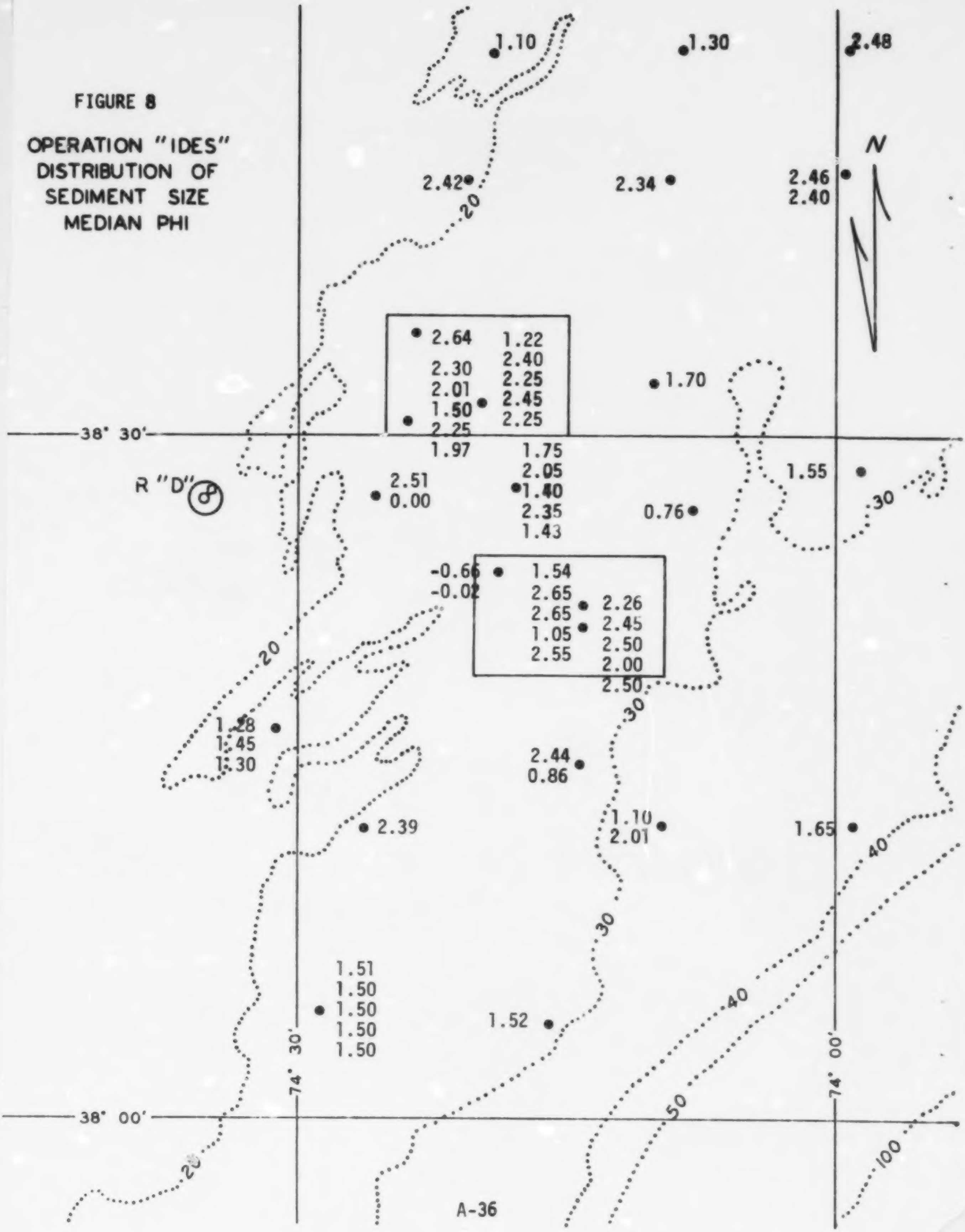
OPERATION "IDES"

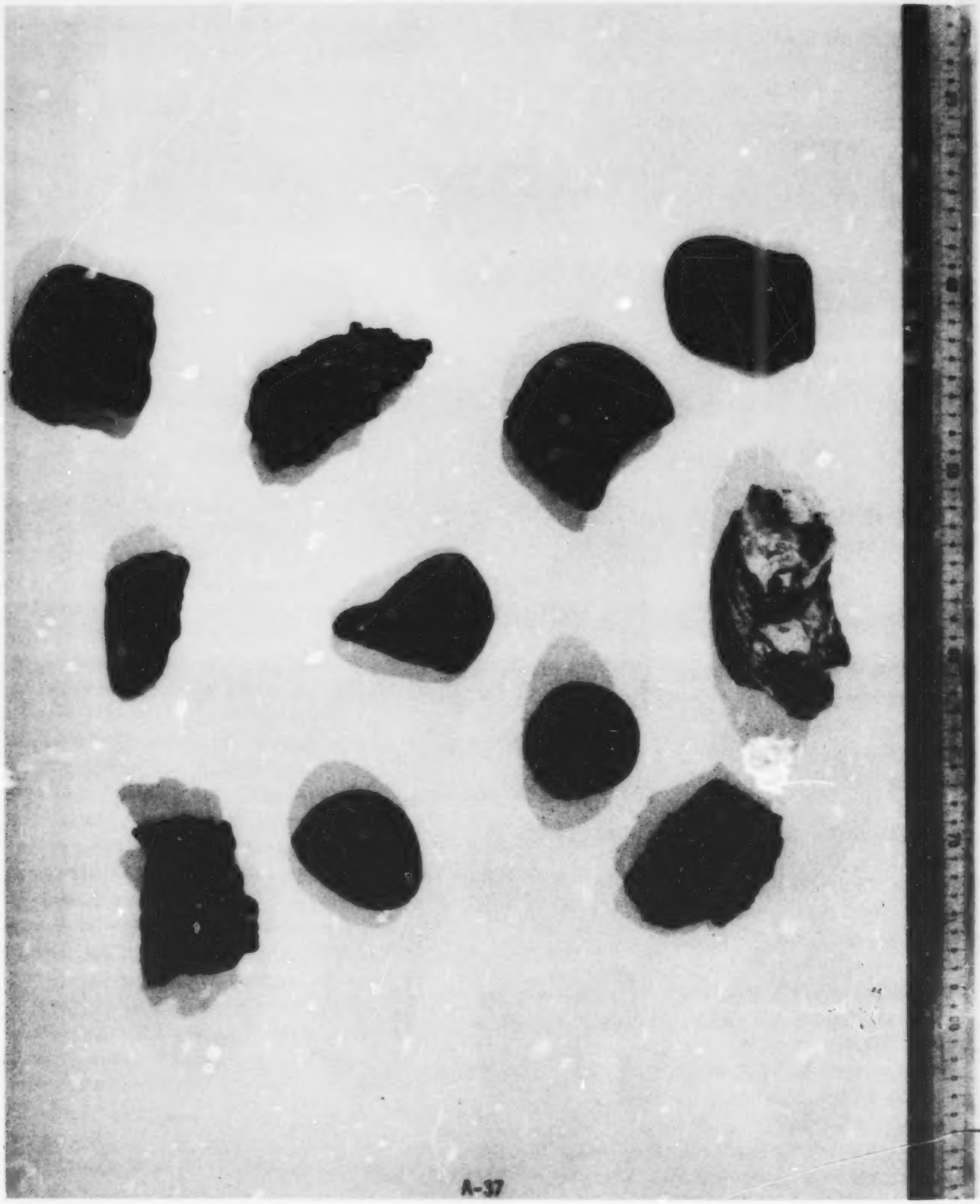
Sediment Size Fractions (continued)
Weight Percent

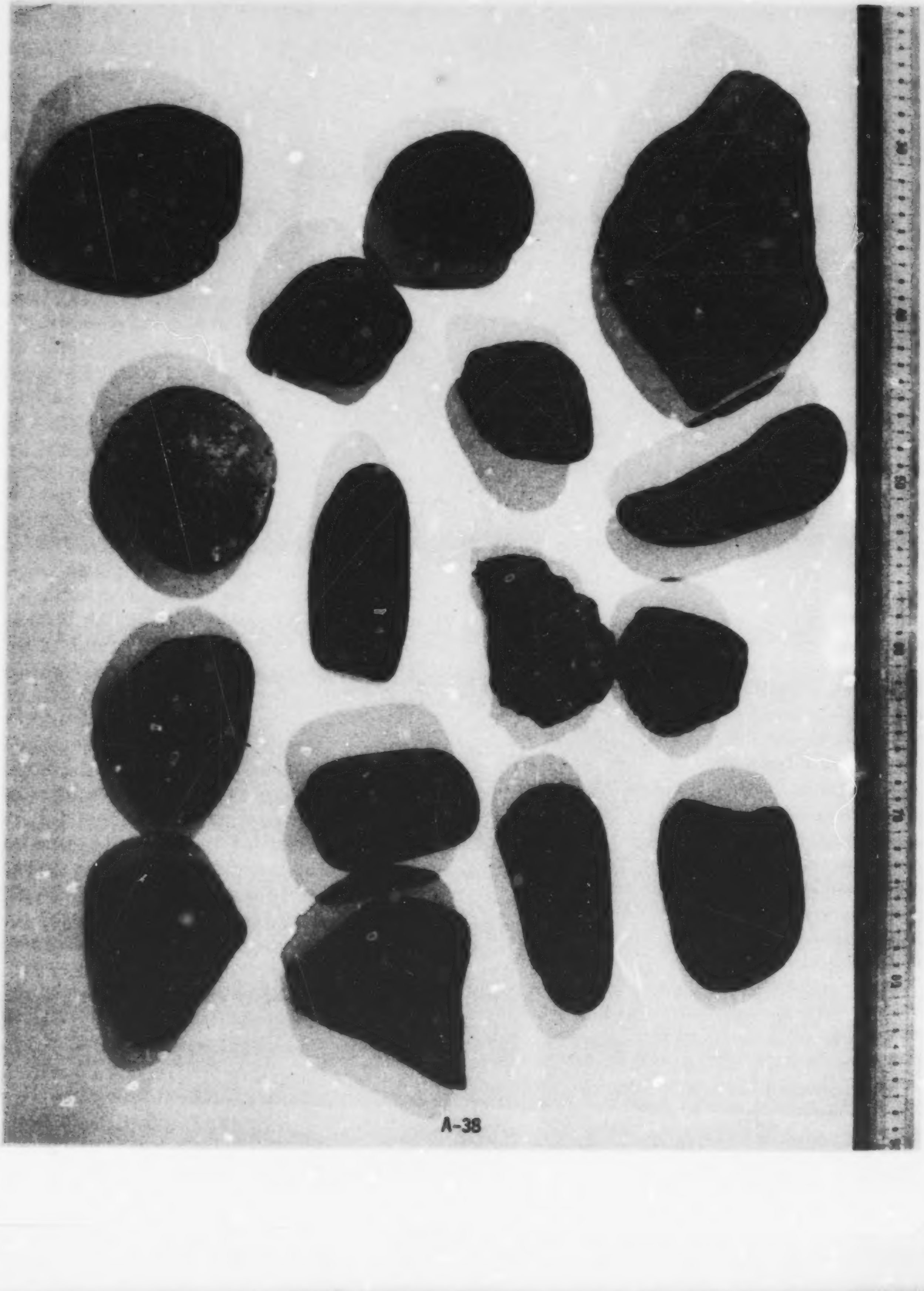
	Dry wt.	Phi-1.0	0.0	1.0	2.0	3.0	4.0	Median
Station	gm	mm -2.0	1.0	0.5	0.25	0.125	0.062	Phi
27	25.01	0.67	0.27	8.44	80.49	9.92	0.03	1.52
28	28.98	0.20	4.86	40.48	48.20	6.21	0.24	1.10
29	30.77	1.33	2.27	18.62	57.43	18.75	0.94	1.30
30	25.65	0.54	0.23	0.23	10.84	83.27	4.67	2.48
A	27.41	0.07	0.03	0.51	15.57	77.82	6.71	2.42
B	22.30	0.49	0.31	1.97	46.64	43.87	0.73	2.01
	30.00	1.33	2.96	16.36	60.76	16.53	1.03	1.50
	27.50	0.72	0.21	1.05	33.16	58.40	6.07	2.25
	35.72	0.08	0.11	1.90	49.66	45.04	2.85	1.97
	29.31	1.80	0.20	0.44	27.49	62.84	6.58	2.30
C	27.02	1.11	6.03	31.05	52.66	8.29	0.25	1.22
	21.03	0.04	0.19	0.51	18.73	73.98	5.99	2.40
	34.07	0.00	0.05	1.50	33.28	60.90	3.61	2.25
	20.58	0.00	0.24	1.31	16.22	74.53	6.51	2.45
	49.57	0.00	0.06	1.39	33.97	61.04	3.30	2.25
D	42.21	1.94	3.36	9.14	47.55	36.79	0.94	1.75
	27.56	0.18	0.25	3.33	43.97	48.73	2.68	2.05
	32.54	2.58	3.90	19.36	58.23	15.48	0.27	1.40
	32.81	0.09	0.12	0.94	25.60	66.62	5.97	2.35
	33.61	1.84	2.85	19.48	58.43	16.30	0.23	1.43
E	30.99	29.62	31.30	23.68	12.00	1.45	0.09	-0.66
	27.35	20.69	37.07	27.75	12.35	1.53	0.10	-0.02
F	30.49	8.88	10.47	26.11	36.08	16.82	1.11	1.10
	21.72	1.15	1.33	9.85	33.19	52.16	1.56	2.01

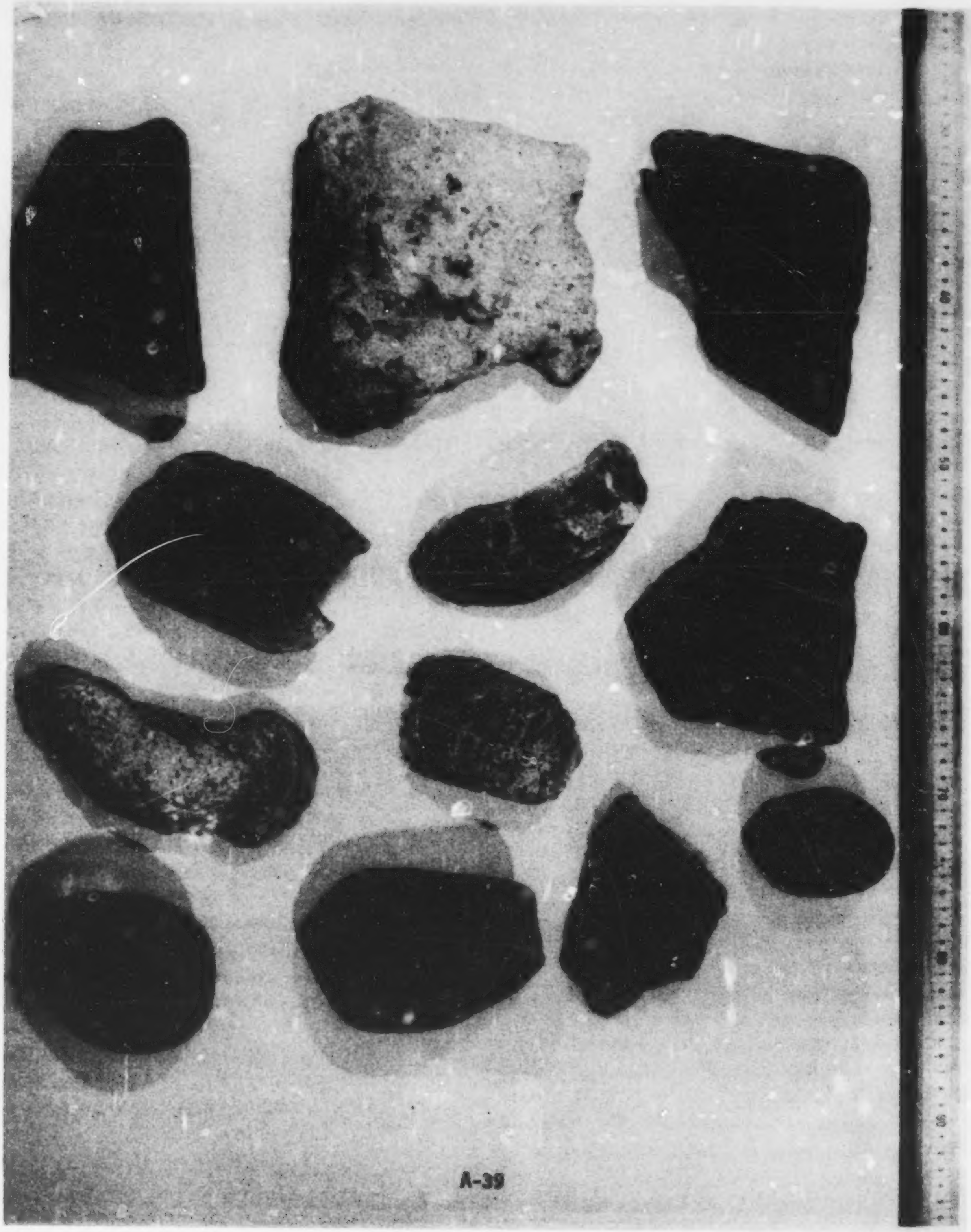
FIGURE 8

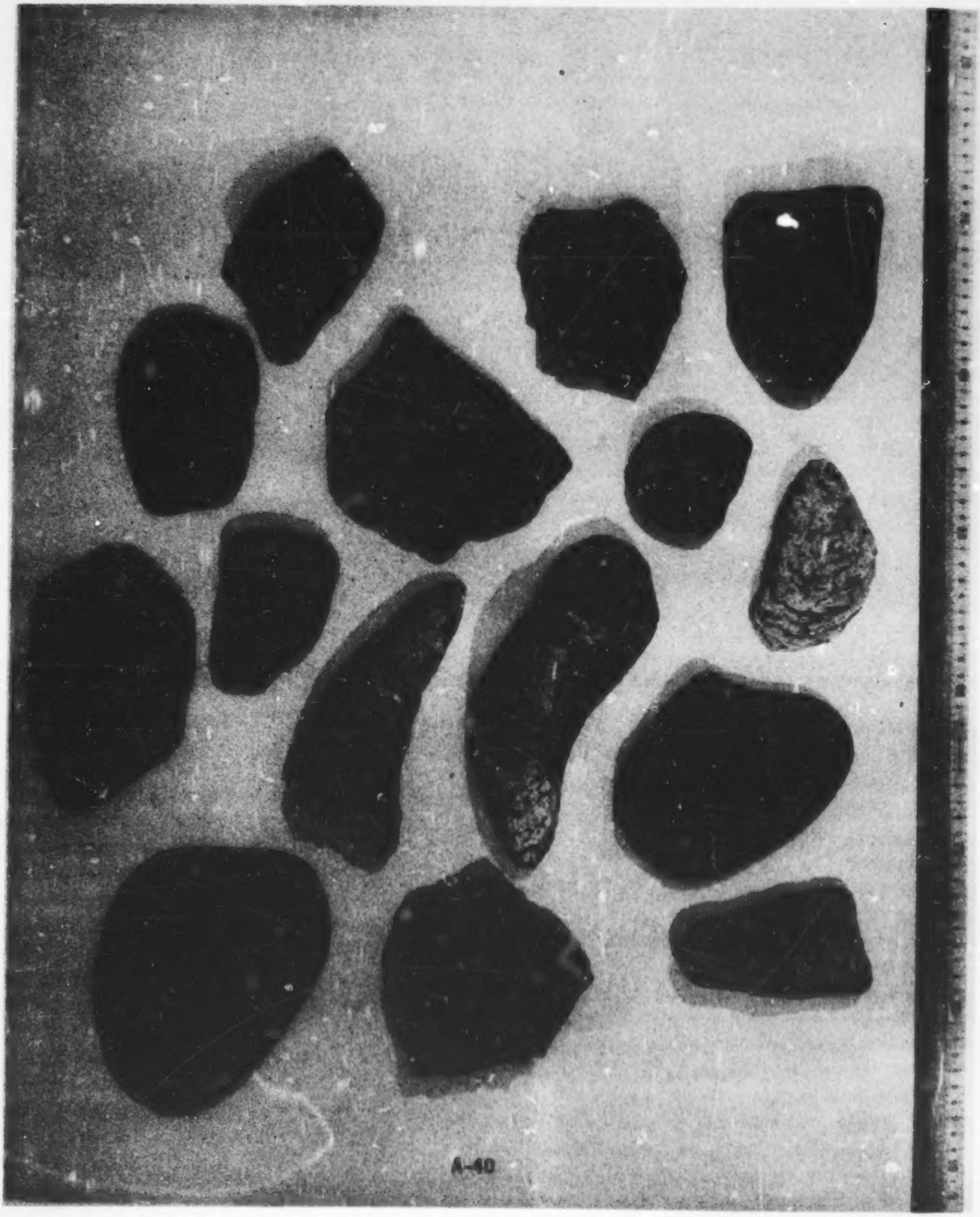
OPERATION "IDES"
DISTRIBUTION OF
SEDIMENT SIZE
MEDIAN PHI


1.10
1.30
2.48
N
2.42
20
2.34
2.46
2.40
2.64
1.22
2.30
2.40
2.01
2.25
1.50
2.45
2.25
2.25
1.70
38° 30'
1.97
1.75
2.05
1.55
R "D"
2.51
0.00
1.40
2.35
1.43
0.76
30
-0.66
-0.02
1.54
2.65
2.65
1.05
2.55
2.26
2.45
2.50
2.00
2.50
20
30
1.28
1.45
1.30
2.44
0.86
2.39
1.10
2.01
1.65
40
30
1.51
1.50
1.50
1.50
1.50
1.52
40
74° 30'
74° 00'
50
38° 00'
20
100









A-40

Table 7

OPERATION "IDES"

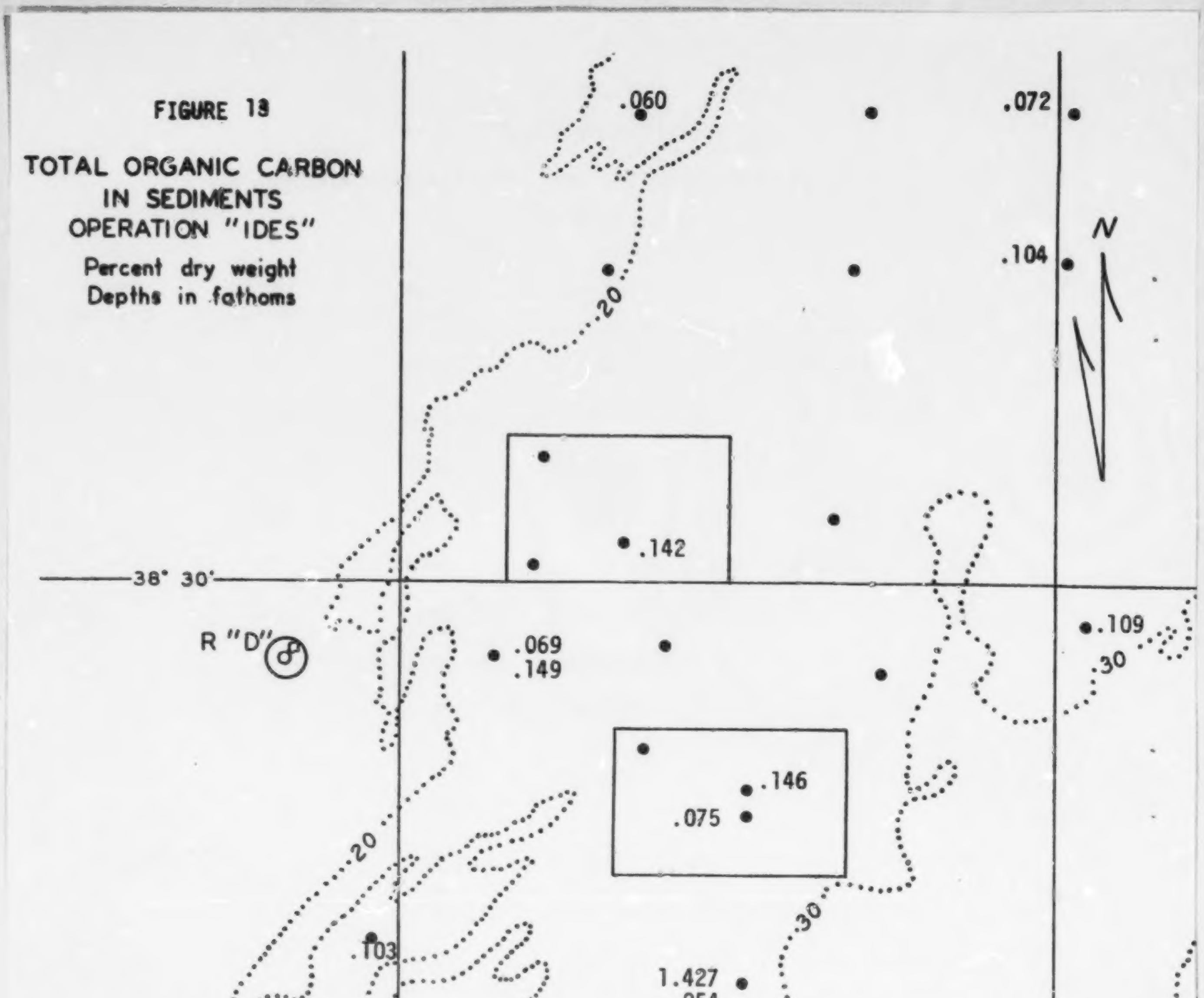
Total Organic Carbon and Total Kjeldahl Nitrogen

Sediments

Station	Date	Time	Wet wt. g/ml	Dry wt. g/ml	TOC % Dry wt.	TKN % Dry. wt.
C	3-11-74	1145	1.8439	1.4625	.142	
2	3-11-74	2039	1.7945	1.4080	.075	
8	3-12-74	0100	1.8275	1.4219	.146	
9	3-12-74	0412	1.8847	1.5477	.103	
14	3-13-74	0515	1.8522	1.5149	.109	
19	3-13-74	1028	1.5784	1.0904	.104	
22	3-14-74	2318	1.8622	1.4310	.069	
22	3-14-74	2318	1.8357	1.3712	.149	
24	3-12-74	2055	1.5171	.8783	1.427	.152
24	3-12-74	2055	1.9462	1.6197	.054	.011
26	3-12-74	2936	1.9055	1.5321	.024	
28	3-13-74	2237	1.8918	1.5502	.060	
30	3-13-74	1540	1.7189	1.2780	.072	

FIGURE 13

TOTAL ORGANIC CARBON
IN SEDIMENTS
OPERATION "IDES"
Percent dry weight
Depths in fathoms



.060
.072
N
.104
20
.142
38° 30'
.109
R "D"
.069
.149
30
.146
.075
20
30
.103
1.427
.054
40
30
40
.024
74° 30'
74° 00'
50
38° 00'
20
100

The distribution of the organohalogens indicates that there may be accrual of these materials in some areas (Table 8, Figure 14).

The distribution of metals in the sediments indicate possible buildup of these materials due to dumping activities (Table 9). For the analysis of the distribution of these metals, the higher concentrations were contoured visually, then the hypothesis was tested statistically that the contoured areas were statistically significant from the remaining areas. The nonparametric Mann-Whitney U-test was used for these purposes and the distributions shown are statistically discrete. It would appear, from the distribution of these metals, that materials from each of the release zones are at this moment settling separately to the bottom (Figures 15-2). The coincidence of the contours makes this hypothesis very tenable. These distributions would indicate that the material released at the acid waste site are distributed around the site and to the northeast, and the materials from the municipal sludge site are distributed in the eastern half of the site and to the southeast. These observations are in accordance with the observed current structure at this time.

Table 8

OPERATION "IDES"

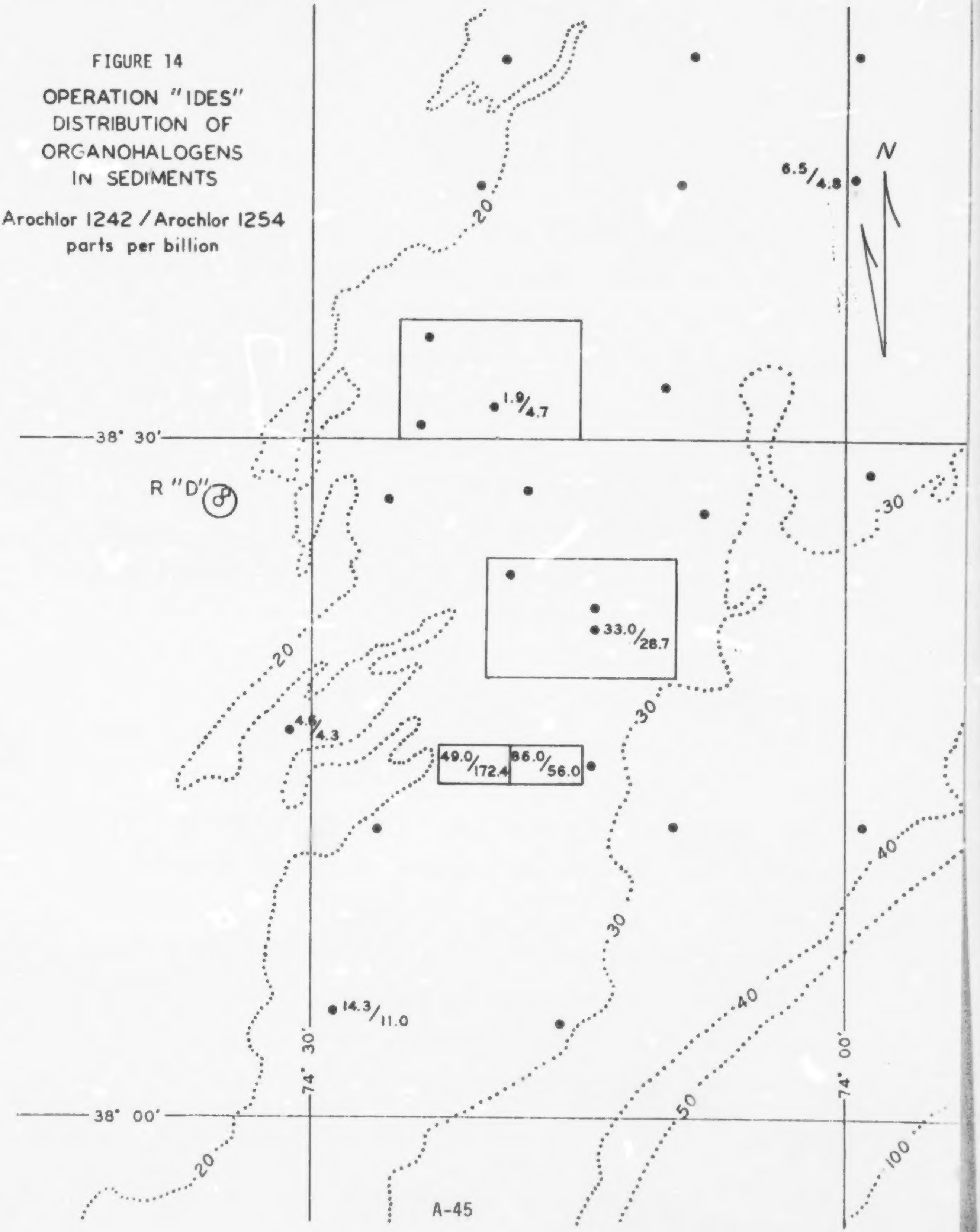
Organohalogens in Sediments

Location	Gms. Extracted Dry Weight	6% Fraction off Florisil Col. Aroclor 1254 (ppb)	Aroclor 1242 (ppb)
Sta. C	81.1808	4.7	1.9
Sta. 2	73.0716	28.7	33.0
Sta. 9	87.0783	4.3	4.6
Sta. 19	78.0302	4.8	6.5
Sta. 24	55.0505	172.4	49.0
Sta. 24 (dup)	74.2666	56.0	86.0
Sta. 26	82.4842	11.0	14.3

FIGURE 14

OPERATION "IDES"
DISTRIBUTION OF
ORGANOHALOGENS
IN SEDIMENTS

Arochlor 1242 / Arochlor 1254
parts per billion


N
6.5/4.8
20
1.9/4.7
38° 30'
R "D"
30
20
33.0/28.7
30
4.6/4.3
49.0/172.4
86.0/56.0
40
30
14.3/11.0
40
74° 30'
74° 00'
50
38° 00'
20
100

OPERATION "IDES"

Metals in Sediments

P. G. Johnson

Sediment samples were taken using a Shipek sampler.

The sediment samples were transferred from whirl-paks to glass jars and well mixed. A portion (approximately 10 grams) was removed and spread to dry at room temperature for 48 hours. The samples were again mixed and pulverized to separate the sand grains and to expose surface areas. At this time any large rocks, pebbles, or shells (>5mm) were removed. The samples were allowed to air-dry at room temperature for an additional 48 hours.

A known weight (5.0000 gms) of dry sediment was put in a 125 ml glass-stoppered flask. Small amounts of deionized-distilled water were used to aid in the transfer. The addition of 21.5 ml of concentrated nitric acid provided a digestion solution of 50-75 ml. This solution was heated at 48-50°C (1) for 4-6 hours in a shaking hot water bath. After digestion, the samples were cooled to room temperature and filtered through a .45 micron membrane filter and the volume adjusted to 100 ml. Blank solutions were run throughout the same digestion procedure (2,3).

The filtered acid extracts were analyzed for Cd, Cr, Cu, Pb, Ni, Zn, Mn, and Fe using a Varian Techtron AA-6 atomic absorption spectrophotometer equipped with a standard pre-mix burner. Air-acetylene was used for all the metals. Standard operating parameters follows.

OPERATION "IDES"

Metals Procedures

Operating Conditions

	Cd	Cr	Cu	Pb	Zn	Ni	Mn	Fe
Lamp Current (ma)	3	5	3	6	5	5	5	5
Fuel	A	A	A	A	A	A	A	A
Support	a	a	a	a	a	a	a	a
Flame Condition	0	R	0	0	0	0	0	0
Wavelength	228.8	357.9	324.7	217.0	213.9	232.0	279.5	386.0
Spectral Band Pass (nm)	.5	.2	.2	1.0	.2	.2	.2	.2
Working Range (mg/l)	.5-2	2-8	2-8	5-20	.4-1.6	3-12	1-4	50-200
Typical Sensitivity (mg/l)	.011	.055	.04	.11	.099	.066	.024	.90

A - acetylene, a - air, 0 -oxidizing, R - reducing

Mercury was analyzed using an automated flameless atomic absorption technique. All sediment results were expressed as mg/kg dry weight.

The organisms were dissected for certain organs or digested whole. The digestion procedure used was the same as that used for the sediments except that a known wet weight was used and the results were expressed as mg/kg wet weight.

The calculations for the sediment and organisms are as follows:

SEDIMENTS: $$\frac{\text{final answer (mg/l)}}{\frac{5.0000 \text{ gms (dry)}}{100 \text{ ml}} \times \frac{1000 \text{ ml}}{1 \text{ L}}} = \text{mg/gm} \times 1000 = \text{mg/kg dry}$$

ORGANISMS: $$\frac{\text{final answer (mg/l)}}{\frac{\text{wet weight (gms)}}{100 \text{ ml}} \quad \frac{1000 \text{ ml}}{1 \text{ L}}} = \text{mg/gm} \times 1000 = \text{mg/kg wet}$$

Table 9

OPERATION "IDES"

Metals in Sediments mg/kg dry wt.

Station	Cd	Cr	Cu	Pb	Zn	Ni	Mn	Fe	Hg
A	<1	2	<1	1	5	1	21	1481	.048
B	<1	3	<1	3	8	1	188	2437	.008
B	<1	2	<1	1	4	<1	19	1654	.014
B	<1	3	<1	3	7	1	35	2427	.032
B	<1	3	<1	3	6	<1	44	2179	.01
B	<1	3	<1	3	7	1	70	2441	.01
C	<1	<1	<1	1	2	<1	14	0838	.014
C	<1	1	<1	2	6	1	45	1816	.056
C	<1	1	<1	2	6	1	27	1813	.020
C	<1	1	<1	3	6	1	32	1810	.022
C	<1	1	<1	2	6	1	24	1772	.01
D	<1	<1	<1	3	3	<1	24	1060	.008
D	<1	2	<1	3	3	<1	15	1190	<.01
D	<1	2	<1	2	2	<1	17	0888	.008
D	<1	2	<1	1	2	<1	18	866	.228
D	<1	3	<1	3	5	1	26	1697	.008
E	<1	2	1	3	4	<1	43	1312	<.01

OPERATION "IDES"

Metals in Sediments mg/kg dry wt. (cont.)

Station	Cd	Cr	Cu	Pb	Zn	Ni	Mn	Fe	Hg
E	<1	1	2	4	3	1	37	1478	.020
F	<1	2	2	5	4	1	19	1654	<.01
F	<1	3	2	7	7	2	136	2261	.012
2	<1	2	1	5	8	1	31	2161	<.01
2	<1	3	1	5	9	1	40	2455	.026
2	<1	3	1	5	9	1	39	2524	<.01
2	<1	3	1	10	9	1	34	2545	<.01
2	<1	2	<1	9	8	2	37	2322	.032
8	<1	3	1	8	5	2	25	2020	.022
8	<1	3	2	8	8	2	38	2524	<.01
8	<1	2	2	10	9	1	55	2588	.01
8	<1	1	1	6	4	2	31	1373	.042
8	<1	2	1	10	8	1	38	2389	.009
9	<1	<1	<1	4	3	1	17	928	<.01
9	<1	<1	<1	4	3	1	16	1086	<.01
9	<1	<1	<1	4	2	2	18	920	.092
9	<1	1	<1	4	5	<1	30	1751	.100
9	<1	2	<1	2	3	<1	17	1129	<.01

OPERATION "IDES"

Metals in Sediments mg/kg dry wt. (cont.)

Station	Cd	Cr	Cu	Pb	Zn	Ni	Mn	Fe	Hg
14	<1	3	<1	3	4	<1	33	1478	<.01
14	<1	3	<1	2	4	<1	29	1532	<.01
17	<1	3	<1	1	4	2	19	1607	<.01
18	<1	4	2	5	7	1	38	2265	.024
19	<1	3	1	5	7	1	56	2031	<.01
19	<1	3	<1	6	6	1	53	1916	.046
20	<1	5	1	5	11	3	40	3016	<.01
21	<1	2	<1	3	3	1	42	1510	<.01
22	<1	4	1	4	9	3	56	2930	.01
22	<1	7	1	5	7	3	26	2344	<.01
23	<1	3	<1	4	5	3	52	1992	.036
24	1	11	12	14	32	16	131	10750	<.01
24	<1	2	<1	3	3	1	34	1643	<.01
25	<1	2	1	3	4	2	38	1668	.004
26	<1	1	<1	2	3	1	15	1012	<.01
26	<1	1	<1	2	2	1	16	947	<.01
26	<1	2	<1	2	2	<1	13	920	<.01

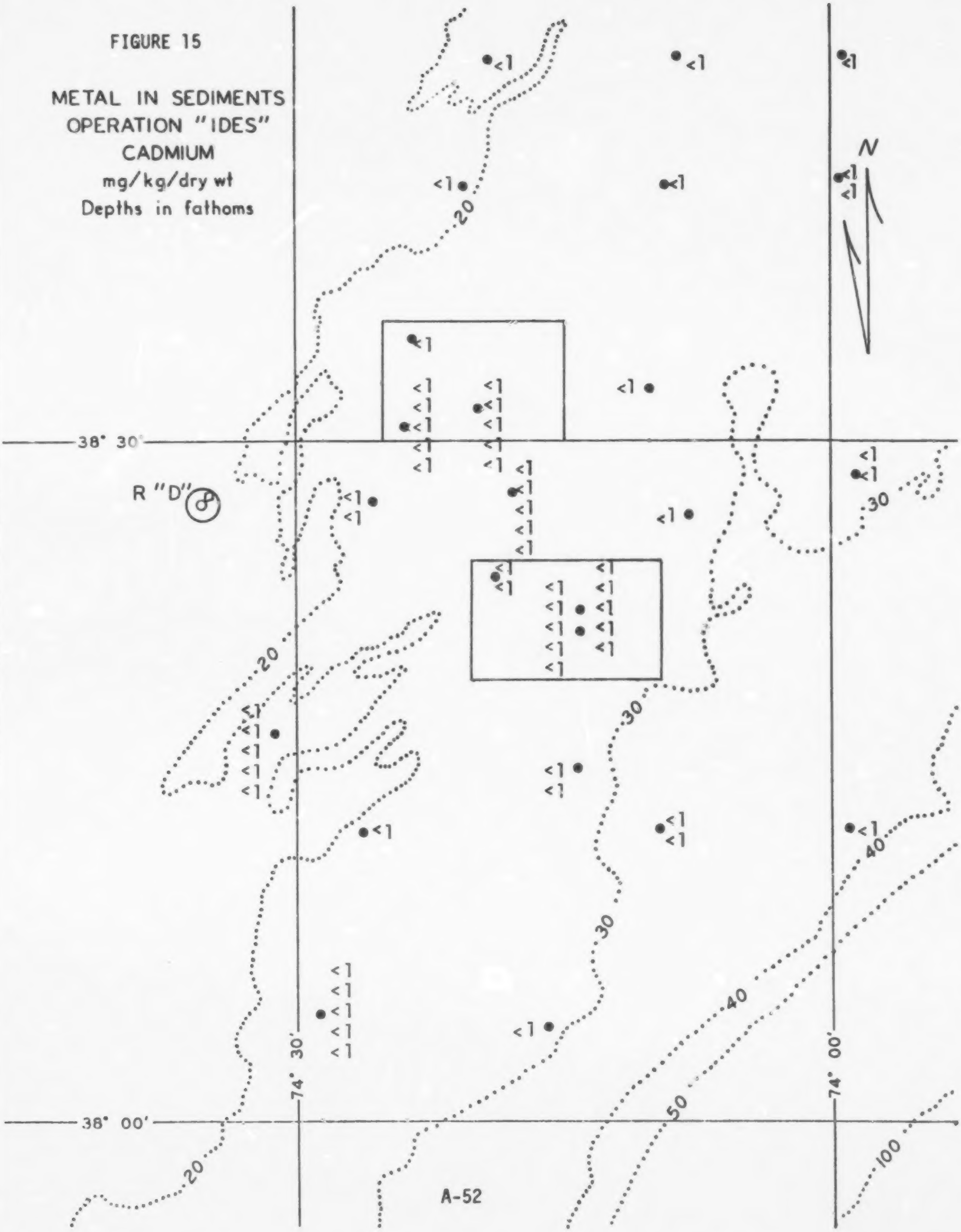
OPERATION "IDES"

Metals in Sediments mg/kg dry wt. (cont.)

Station	Cd	Cr	Cu	Pb	Zn	Ni	Mn	Fe	Hg
26	<1	1	<1	2	2	<1	15	910	.036
26	<1	1	<1	3	2	<1	15	884	<.01
27	<1	2	<1	2	4	<1	32	1751	<.01
28	<1	3	<1	4	5	<1	51	3171	.008
29	<1	2	<1	2	3	<1	8	1463	<.01
30	<1	3	1	4	6	2	34	2204	<.01

FIGURE 15

METAL IN SEDIMENTS
OPERATION "IDES"
CADMIUM
mg/kg/dry wt
Depths in fathoms



N
38° 30'
38° 00'
74° 30'
74° 00'
R "D"
20
30
40
50
100
<1

FIGURE 16

METAL IN SEDIMENTS
OPERATION "IDES"
CHROMIUM
mg/kg/dry wt
Depths in fathoms

Contoured concentrations are significantly greater than others

z = 3.28
P = >0.01

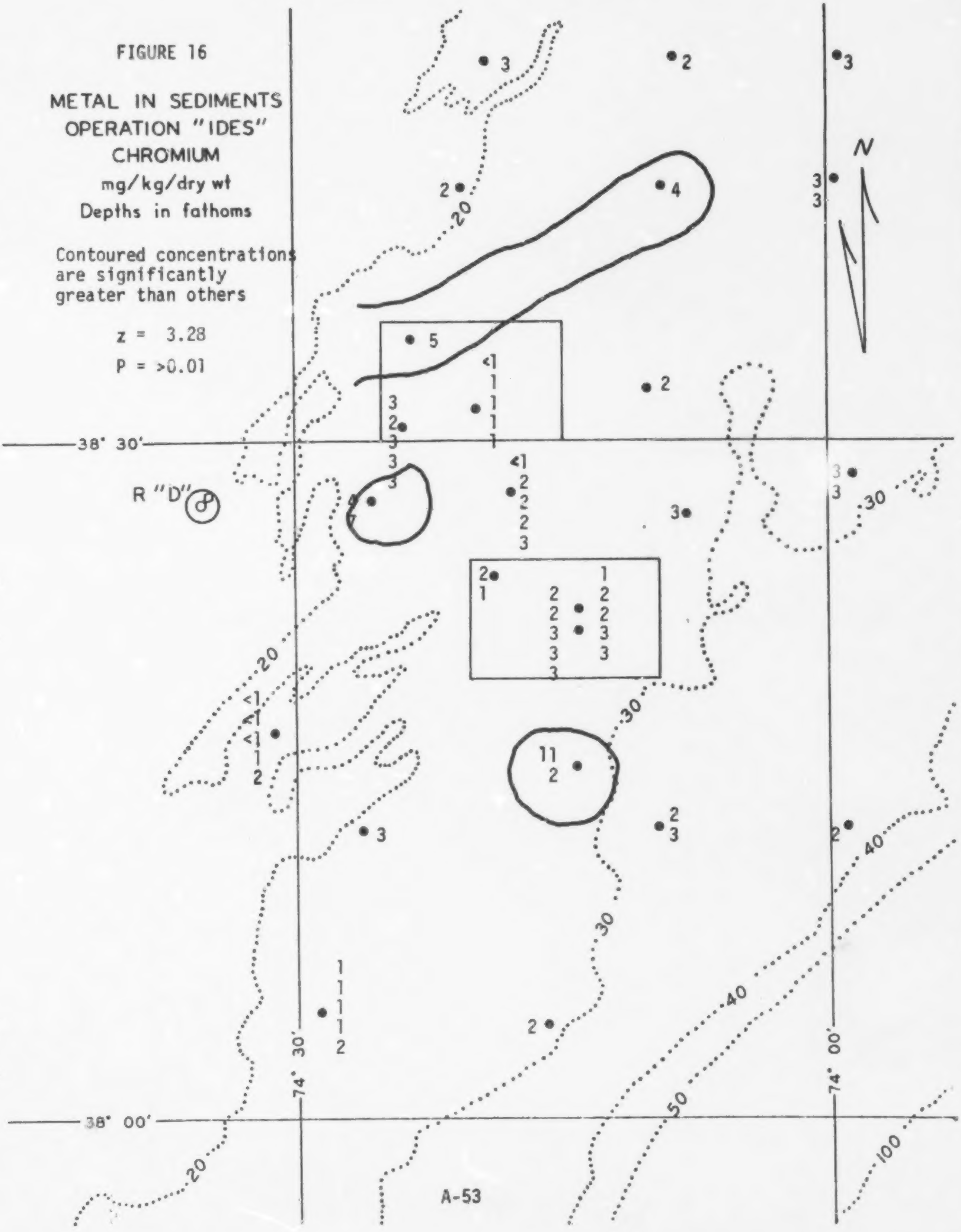

N
38° 30'
38° 00'
74° 30'
74° 00'
R "D"
20
20
20
30
30
30
30
40
40
50
100

FIGURE 17

METAL IN SEDIMENTS
OPERATION "IDES"
COPPER
mg/kg/dry wt
Depths in fathoms

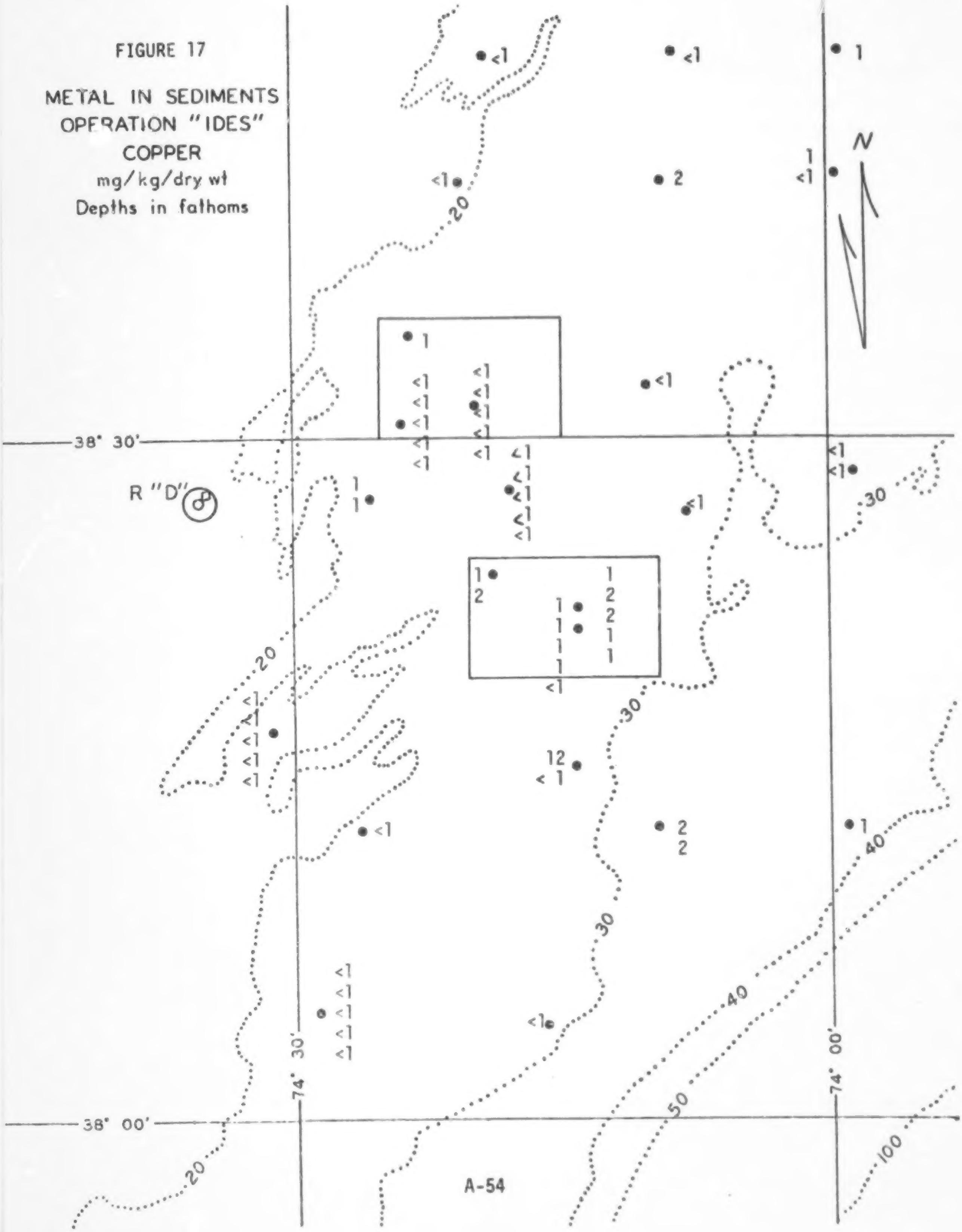

N
38° 30'
38° 00'
74° 30'
74° 00'
R "D"
20
30
40
50
100
<1
1
2
12

FIGURE 18

METAL IN SEDIMENTS
OPERATION "IDES"
LEAD
mg/kg/dry wt
Depths in fathoms

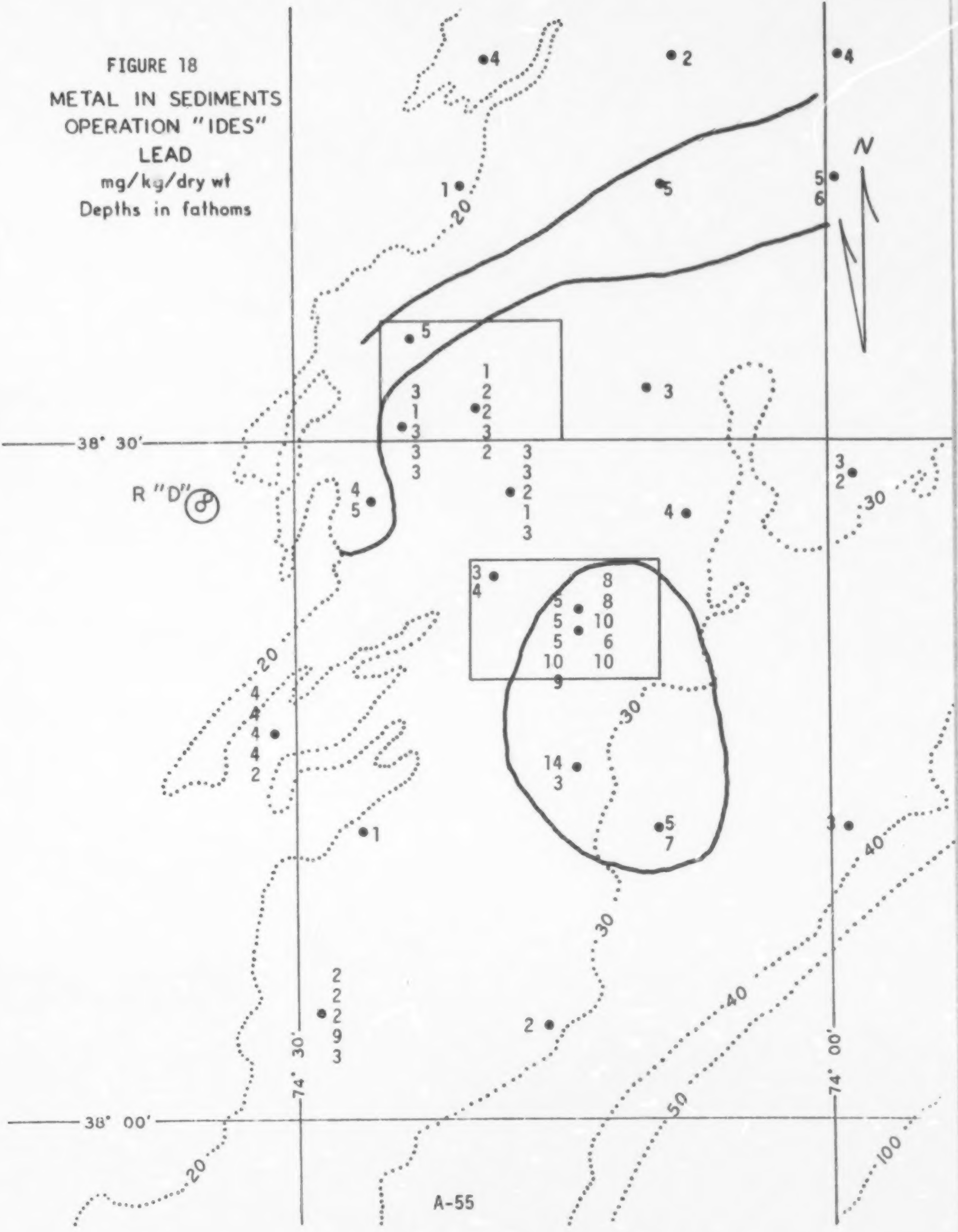
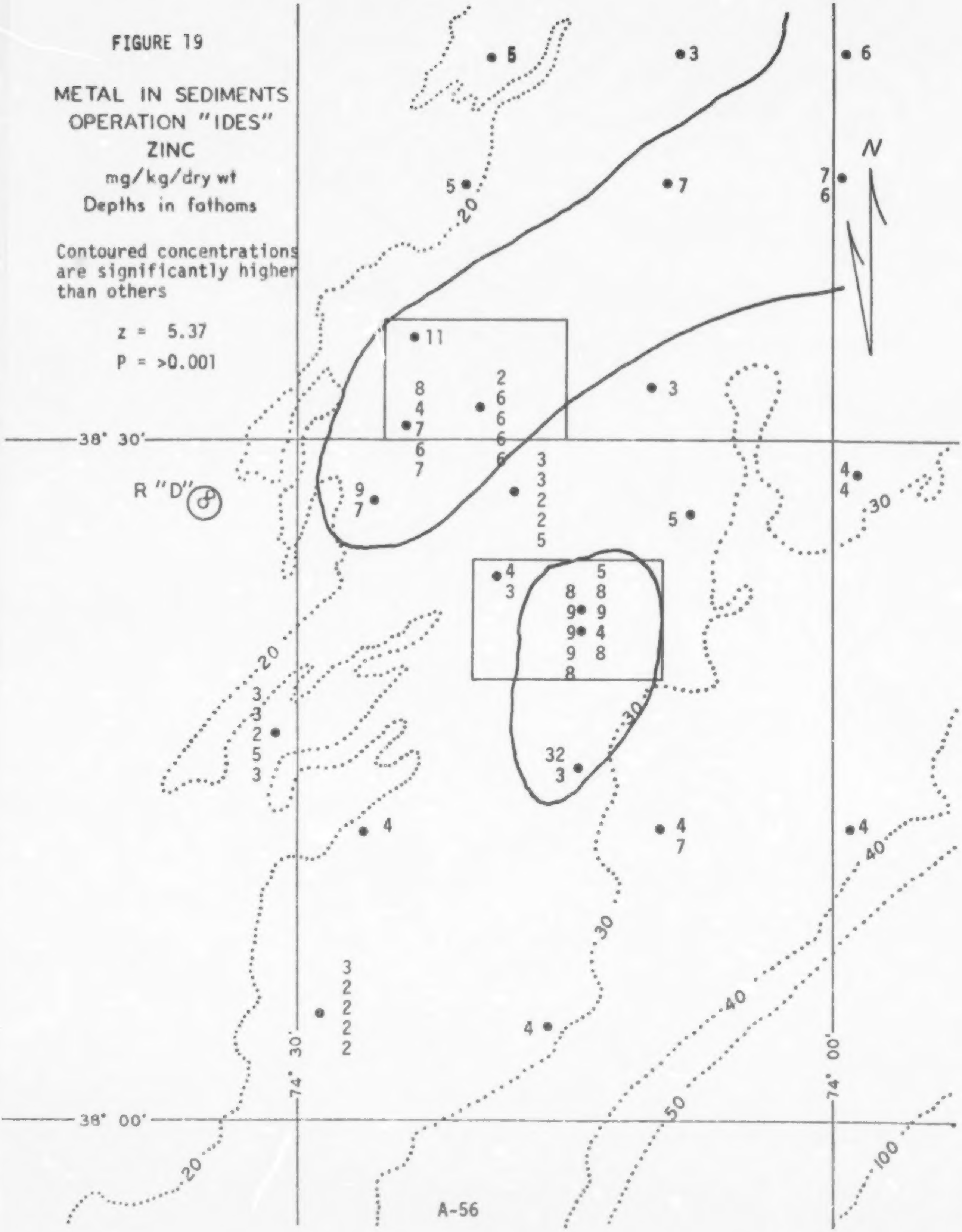

N
38° 30'
38° 00'
74° 30'
74° 00'
R "D"
20
30
40
50
100
4
2
4
1
5
5
6
5
1
2
2
3
2
3
1
3
3
3
3
3
3
2
1
3
3
4
5
4
3
2
3
4
8
8
5
5
10
5
6
5
10
10
10
9
4
4
4
4
2
14
3
5
7
1
3
2
2
2
9
3
2

FIGURE 19

METAL IN SEDIMENTS
OPERATION "IDES"
ZINC
mg/kg/dry wt
Depths in fathoms

Contoured concentrations are significantly higher than others

z = 5.37
P = >0.001



N
38° 30'
38° 00'
74° 30'
74° 00'
R "D"
20
20
20
30
30
30
30
40
40
40
50
100
5
3
6
5
7
7
6
11
8 4 7 6 7
2 6 6 6 6
3
9 7
3 3 2 2 5
4 4
5
4 3
5 8 9 4 8
8 9 9 9 8
3 3 2 5 3
32 3
4
4 7
4
3 2 2 2 2
4

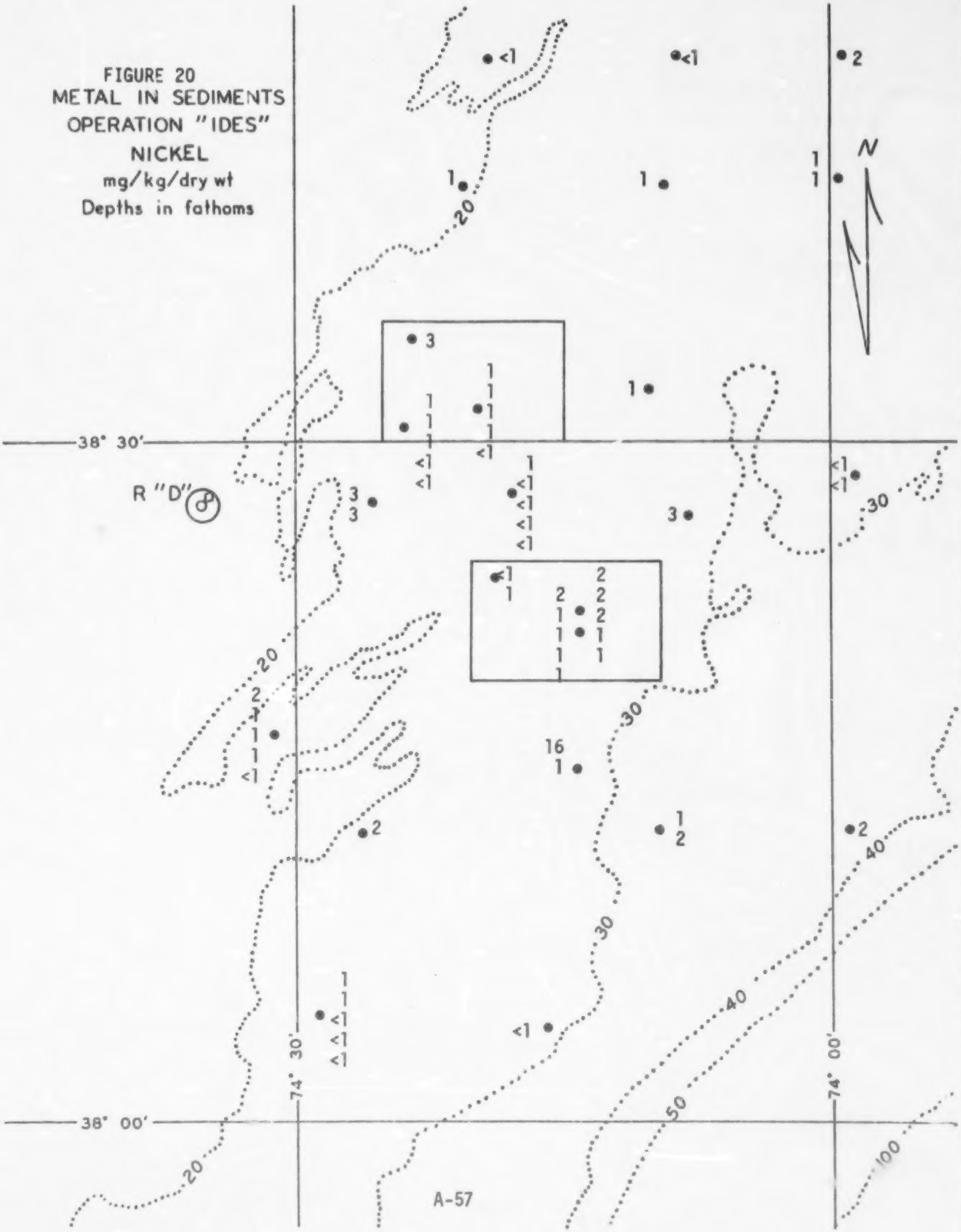


FIGURE 20
METAL IN SEDIMENTS
OPERATION "IDES"
NICKEL
mg/kg/dry wt
Depths in fathoms

N
38° 30'
38° 00'
74° 30'
74° 00'
R "D"
20
30
40
50
100
<1
<1
2
1
1
1
1
3
1
1
1
1
1
1
1
1
<1
<1
<1
1
<1
<1
<1
<1
<1
<1
3
3
3
<1
<1
30
<1
1
2
2
2
2
1
1
1
1
1
1
1
2
1
1
1
<1
16
1
2
1
2
2
1
1
<1
<1
<1
<1

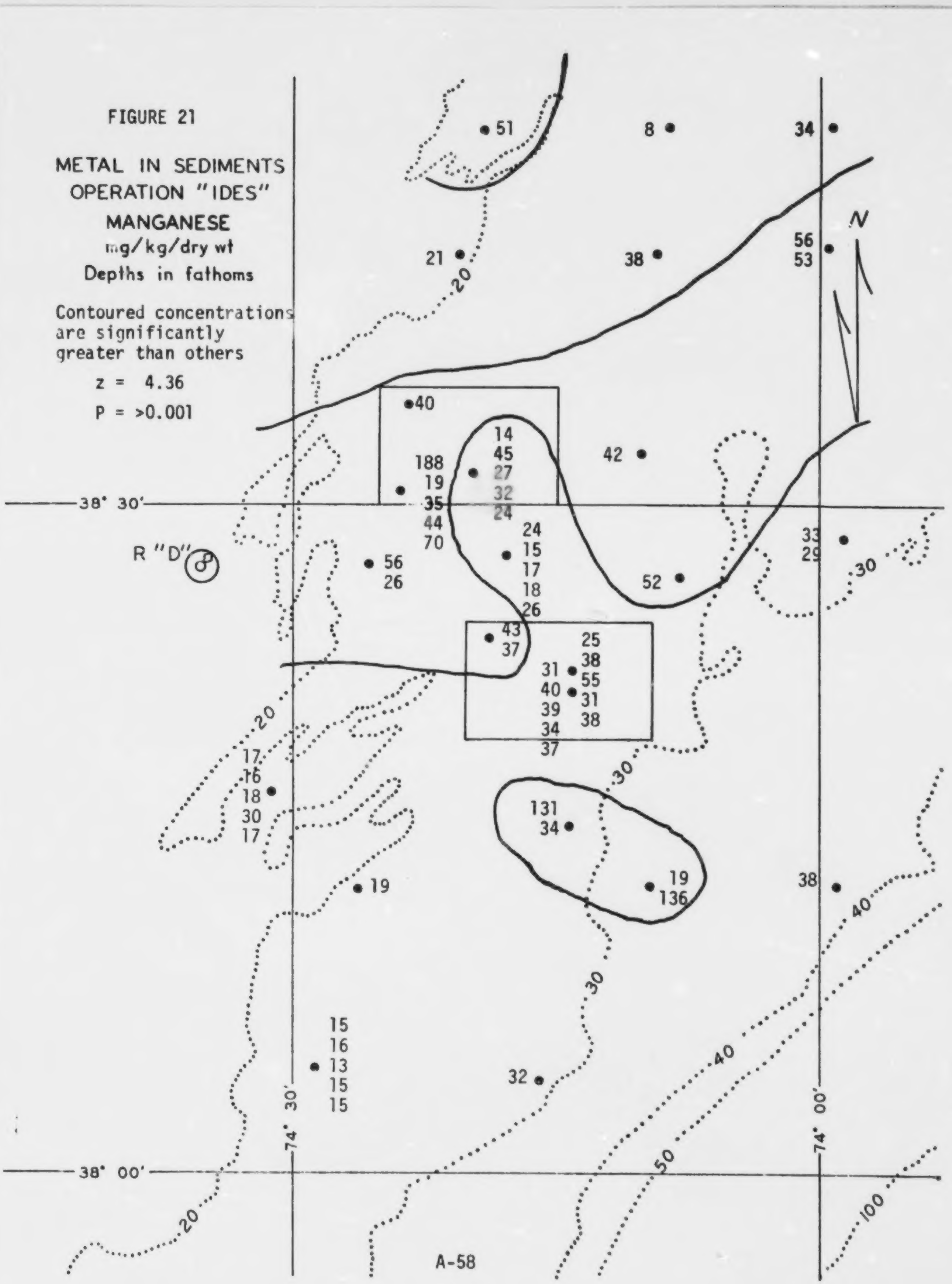


FIGURE 21

METAL IN SEDIMENTS
OPERATION "IDES"
MANGANESE
mg/kg/dry wt
Depths in fathoms

Contoured concentrations are significantly greater than others

z = 4.36

P = >0.001

51
8
34
21
38
56
53
N
20
40
14
45
27
32
24
188
19
35
44
70
42
38° 30′
R "D"
56
26
24
15
17
18
26
52
33
29
30
43
37
25
38
55
31
38
31
40
39
34
37
20
30
17
16
18
30
17
131
34
19
136
19
38
40
30
15
16
13
15
15
32
40
74° 30′
74° 00′
50
38° 00′
20
100

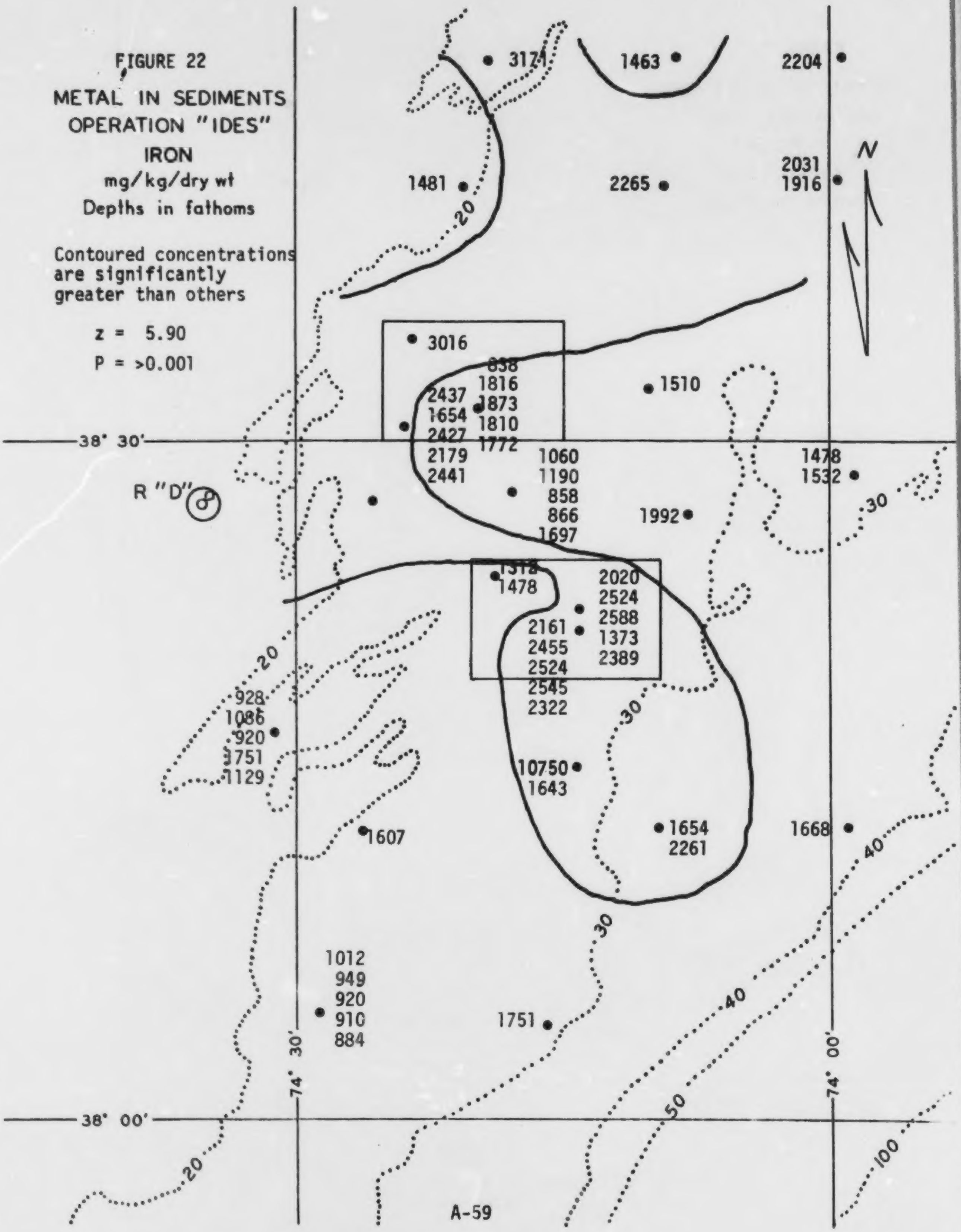


FIGURE 22

METAL IN SEDIMENTS
OPERATION "IDES"
IRON
mg/kg/dry wt
Depths in fathoms

Contoured concentrations are significantly greater than others

z = 5.90
P = >0.001

3171
1463
2204
N
1481
20
2265
2031
1916
3016
838
1816
1873
1810
1772
2437
1654
2427
2179
2441
1510
38° 30'
1060
1190
858
866
1697
1478
1532
R "D"
1992
30
1318
1478
2020
2524
2588
1373
2389
2161
2455
2524
2545
2322
20
928
1086
920
1751
1129
30
10750
1643
1654
2261
1668
1607
40
30
1012
949
920
910
884
1751
40
74° 30'
74° 00'
50
38° 00'
20
100

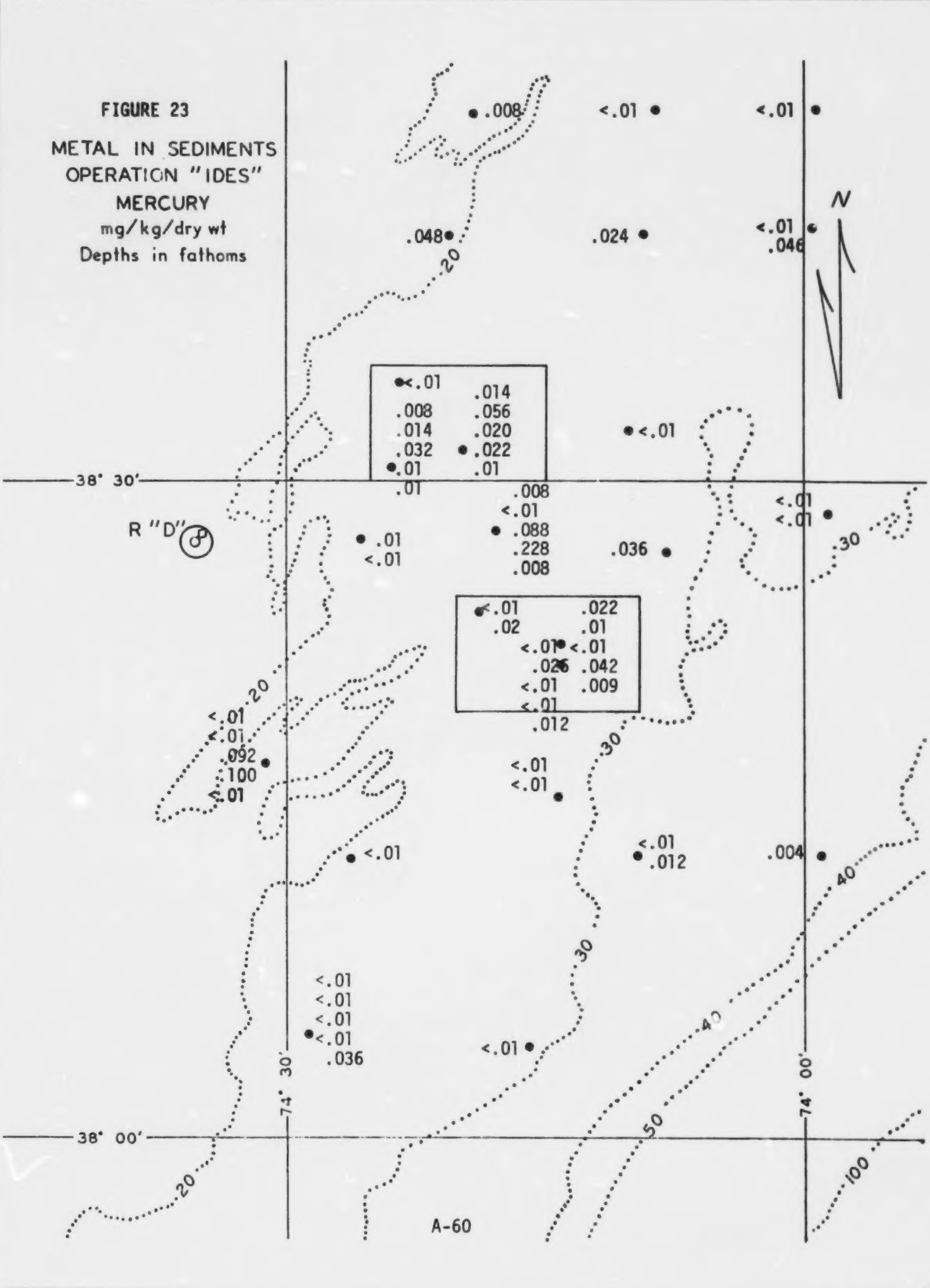


FIGURE 23

METAL IN SEDIMENTS
OPERATION "IDES"
MERCURY
mg/kg/dry wt
Depths in fathoms

.008
<.01
<.01
N
.048
.024
<.01
.046
20
<.01
.014
.008
.056
.014
.020
.032
.022
.01
.01
<.01
.01
38° 30'
.008
<.01
<.01
<.01
R "D"
.01
.088
<.01
.228
.036
30
.008
<.01
.022
.02
.01
<.01
<.01
.026
.042
<.01
.009
<.01
.012
20
<.01
<.01
.092
.100
<.01
30
<.01
<.01
<.01
<.01
.012
.004
40
30
<.01
<.01
<.01
<.01
.036
<.01
40
74° 30'
74° 00'
50
38° 00'
20
100

Table 10

OPERATION "IDES"

Metal Concentrations in Arctica
ppm/dry wt.

Sta/Reps.	V	Zn	Cd	Ag	Cu	Cr	Mn	Co	Ni	Ti	Al	Fe	Pb
2 (2)	14.66	128.5	2.52	1.53	9.55	4.13	9.63	1.09	11.59	6.55	103.4	438.6	6.11
9 (10)	26.46	114.4	1.73	2.33	9.73	3.99	19.89	1.07	6.63	5.20	125.4	354.7	3.61
14 (4)	8.18	92.1	2.78	1.11	7.04	2.95	9.39	1.17	13.36	2.54	40.6	264.3	6.08
17 (10)	19.49	100.7	1.98	0.85	7.89	3.65	14.03	0.83	6.77	3.53	38.0	320.0	4.92
20 (5)	10.95	127.7	1.77	0.76	9.67	4.92	26.09	1.32	9.56	3.49	60.1	562.1	6.47
22 (10)	21.48	111.0	1.62	0.76	10.36	5.04	13.83	1.12	6.47	6.35	162.5	469.6	3.09
24 (3)	16.20	104.5	2.36	0.69	8.02	4.09	5.20	0.87	9.11	1.62	36.3	142.9	2.41
25 (10)	5.46	92.0	4.01	1.41	8.34	5.26	7.98	0.68	10.80	2.40	103.5	281.0	5.33
26 (2)	21.44	90.0	1.73	0.58	8.85	5.17	10.96	0.57	4.21	4.79	87.6	290.6	3.44
27 (10)	9.41	100.1	2.46	1.09	6.59	4.80	10.07	1.01	10.61	2.96	85.0	317.5	5.34
28 (6)	7.47	152.4	2.08	1.77	11.31	5.67	16.95	1.56	11.73	3.01	48.6	261.3	3.57
29 (5)	8.38	107.5	1.91	0.66	7.63	4.03	17.98	1.23	8.85	3.36	65.0	288.5	4.14
A (4)	7.93	117.2	1.77	0.62	9.79	4.77	11.14	1.34	8.34	7.09	112.0	417.1	4.21
B (5)	13.46	107.3	1.61	0.73	9.55	6.07	22.37	1.06	7.79	20.38	341.1	562.4	4.51

OPERATION "IDES"

Metal Concentrationslin Arctica (continued)
ppm/dry wt.

Sta/Reps.	V	Zn	Cd	Ag	Cu	Cr	Mn	Co	Ni	Ti	Al	Fe	Pb
C (6)	11.23	90.5	1.48	0.83	8.86	5.18	12.85	0.72	7.35	7.20	121.6	480.4	5.89
E (7)	19.78	88.2	2.04	0.67	8.60	4.21	11.15	0.79	5.26	6.98	161.0	449.8	4.24
F (10)	5.86	89.4	2.41	0.65	6.64	4.02	10.61	0.95	10.53	8.77	183.5	492.3	3.54

Table 11

OPERATION "IDES"

Metal Concentrations in Scallops
ppm/dry wt.

Sta/Reps	V	Cd	Zn	Ni	Cu	Cr	Ag	Ti	Mn	Al	Fe	Pb	Co
28 (3)	14.66	10.06	31.59	1.10	4.79	1.28	0.46	7.35	17.11	144.7	575 7	1.22	0.33
18 (8)	27.69	11.44	45.52	1.91	5.16	2.76	0.71	17.27	41.76	505.9	1409.7	2.45	0.65
20 (2)	24.99	10.80	42.08	1.65	5.63	2.01	1.11	16.30	22.72	312.5	682.4	1.64	0.78
21 (4)	31.22	14.21	40.50	2.06	5.25	2.90	0.64	8.68	29.26	202.8	1180.8	2.06	0.43
23 (6)	30.75	19.55	57.77	4.34	8.30	2.08	1.24	9.26	11.95	139.1	250.9	11.15	0.66
27 (4)	21.29	55.88	53.43	1.35	6.28	3.26	0.43	9.19	22.83	204.1	1110.0	6.91	0.54
19 (3)	17.93	37.51	38.50	1.06	4.27	2.85	0.39	4.98	32.17	151.9	564.8	1.84	0.48
24 (10)	40.15	22.56	73.00	1.97	6.14	1.17	0.43	5.48	18.48	155.0	291.1	1.54	0.58
25 (2)	23.08	25.96	98.59	4.19	6.73	0.89	1.13	6.21	12.86	126.5	243.4	3.73	0.76
30 (3)	17.53	19.60	107.48	1.03	4.01	1.42	0.50	8.47	30.36	228.8	314.1	1.69	0.38
F (10)	26.66	24.87	100.70	2.99	6.81	4.56	0.81	26.22	63.21	903.9	852.9	3.96	1.02
14 (8)	27.13	59.28	95.90	1.89	6.69	3.12	0.48	12.00	32.76	617.1	299.3	1.89	0.65
2 (5)	52.16	10.95	118.03	14.67	12.66	2.66	9.08	5.02	16.11	92.4	190.5	2.45	0.52
8 (10)	43.60	11.98	113.32	7.14	8.83	2.49	3.76	6.34	27.29	183.8	380.1	6.48	0.35
17 (9)	48.56	15.12	121.71	6.00	8.81	4.19	2.15	10.97	38.77	774.9	342.1	3.99	0.41
26 (5)	58.65	10.79	117.95	13.65	9.50	6.88	4.93	1.06	13.01	78.2	285.9	5.78	0.69

OPERATION "IDES"

Metal Concentrations in Scallops (continued)
ppm/dry wt.

Sta/Reps.	V	Cd	Zn	Ni	Cu	Cr	Ag	Ti	Mn	Al	Fe	Pb	Co
9 (3)	50.55	15.60	116.33	2.08	7.54	2.64	0.45	4.53	24.26	91.9	260.7	2.52	0.29
E (10)	44.12	11.08	108.47	2.64	6.31	3.31	0.58	6.03	28.81	200.5	400.1	2.80	0.48
22 (10)	40.65	14.70	127.35	6.33	8.63	4.05	2.96	6.82	26.88	166.3	249 8	1.83	0.45

SCIENTIFIC LOG
Operation "IDES"

March 11, 1974

0200 - Depart Lewes, Delaware

0805 - On Station A - 19 fathoms - Loran 3512 3065 - moderate sea,
wave height 5', 0% clouds, winds N 8-10

0830 - Water column profile, salinometer probe cut off by prop
BT - Shipek 6 replicates - some dead sand dollars
1 metal sample - phytoplankton sample taken

0944 - Dredge over & fishing

1025 - Dredge on board - good catch Arctica, sand dollars, skate,
flounder, starfish, Polinices, sponge cancer,
old, large, thick oyster shells & cobbles brought up in dredge
NBS thermometer broken

1100 - Underway to Station C

1145 - On Station C - 24 fathoms - Loran 3420 3043 - slight sea,
wave height 3-4', 100% clouds, rain - winds N 7-10
BT taken - no thermocline - surface temp. 8.2°C

1230 - Hydrocast

Depth
20'
75'
100'
140'

Niskin bacti taken - Shipek 6 replicates (some dead sand dollars)
5 metals, 1 pesticide, 1 sediment size

1258 - Current meter array 3407 3041

March 11, 1974

1330 - Clam dredge 30 minutes, good catch - Arctica, skates, eel starfish, sand dollars, Cancer, Polinices, Astarte, 4 spotted flounder, muscles, goosefish, cobbles, iron covered module - zooplankton tow - Secchi disc 7 m.

1430 - Otter trawl - 25 minutes, good catch, starfish, juvenile flounder, skate egg cases, blood stars, skates, 4 spotted flounder, goosefish, large hake, juvenile sculpin, sand dollars

1509 - Underway to Station B

1537 - Arrive Station B - 20 fathoms - Loran 3395 3053

Slight sea, wave height 1-2', 20% clouds, wind N 3-4

1540 - Shipek - 6 replicates, 5 metals, phytoplankton sample taken, Secchi disc 7 meters

1608 - Clam dredge 30 minutes, zooplankton 15 minutes

clam dredge,good catch, many live sand dollars, Pagurus in Polinices, Cancer erroratus, Arctica live & boxes, scallops, starfish, Spisula shell, cobbles

1710 - Underway to Station D

1745 - Station D - 17 fathoms - Loran 3401 3030, slight sea, wave height 1-2', 20% clouds,wind N 3-4

1755 - Clam dredge over & fishing, flounder, 4 skates, starfish, Arctica, 1 goosefish, 1 sand dab, 2 Cancer, approx. bucket of shells

Shipek - 6 replicates, 5 metals taken, phytoplankton sample taken

March 11, 1974

1918 - Otter trawl over - trawl rolled, no catch, aborted

2039 - Station 2 - 30 fathoms - Loran 3356 3009, calm sea, wave height 1-2', 100% clouds, wind N 1-2, snow

2100 - Current meters over 3358 3009

2130 - Hydrocast

Depth	pH
1	
18	
36	
50	

Shipek - 6 replicates, 5 metals, 1 sediment size, 1 pesticide

Bacti, sediment & bottom waters

2115 - BT - surface temp. 8°C

2200 - Clam dredge, small catch, Arctica, Pagurus, 1 scallop

0005-0025 - Trawl over & fishing, good catch, scallops, squid, summer flounder, sand dollar, 4 spotted flounder, starfish sand dab, Cancer, hake, goosefish, pompano, juvenile flounder, sand shrimp, juvenile skate, unknown spotted fish

Underway to Station 8

March 12, 1974

0045 - Station 8 - 25 fathoms - Loran 3361 3008, calm sea

100% clouds, heavy snow

Hydrocast

Depth
4
23
30
45

March 12, 1974

0045 - Station B (cont.) BT, surface temp 6°C, phytoplankton sample taken, Shipek 6 replicates, 5 metals, bacti, sediment sample, water sample

0200 - Clam dredge 40 minutes, zooplankton tow 15 minutes

0255 - Underway to Station 9

0418 - On Station 9 - 23 fathoms - Loran 3217 3051, slight sea wave height 2-3', wind NE 5, 100% clouds

Hydrocast

Depth (m)
4
15
23
30
[illegible]

BT, surface temp 5°C, phytoplankton, bacti, sediment sample, water sample, Shipek 6 replicates, 5 metals, 1 pesticide, strange black line across top of sample collected for metals

0500 - Clam dredge out & fishing, 40 minutes duration for tow, zooplankton tow 15 minutes, lost #10 bucket off 1 C-B net, duplicate tow made

0605 - Trawl over & fishing, 40 minute tow

0650 - Underway to Station 17

0735 - On Station 17 - 27 fathoms, Loran 3181 3030, calm sea, wave height 2-3', winds NE 10, clearing, Shipek, 1 metals sample - clam dredge, good catch C erroratus (young and mature), Arctica (live and boxes), goosefish, flounder, Polinices, scallops, Busyeon shell, Spisula shell,

March 12, 1974

0735 - Station 17 (cont.) sand dollars, starfish, sulfur sponge
Ensis shell, phytoplankton grab
Underway to Station 26

0935 - On Station 26 - 23 fathoms - Loran 3117 3017
Shipek - 5 replicates - 5 metals - sand, silt, clay
Hydrocast surface - phytoplankton sample
16 m
32 m
40 m

1005 - BT 40 m - 9° surface temp. - no trace - not reduced

1010 - Rocking chair overboard and fishing

1040 - Rocking chair aboard - good catch, welk shell, Polinices, skates, flounders, Cardian, Arctica, scallops, Cancer, starfish and sand dollars

1205 - Trawl over and fishing

1236 - Trawl on board - good catch, Bryozoan, sand dollars, starfish, skate, juvenile & adult flounders, scallops, crabs, juvenile sea spider (Libinia dubia), juvenile Cancer, Ensus, hermit crab in Polinices & welk shells, sea horse, Crepidula shell
Discolored water reported from bridge during trawl
Many gulls astern when lying to

1255 - Underway to Station 27

1415 - On Station 27 - 31 fathoms - Loran 3182 2974
Wind 25-30 N - Seastate 4 - 100% clouds - Secchi disc-6 meters
Shipek 5 drops - sea mouse in Shipek drop - phytoplankton sample

1440 - Dredge over and fishing

1517 - Haul dredge - good catch, Polinices, scallops, goosefishes, Crepidula, Arctica, hermit crabs, Pagarues, starfish, eel Spisula shell, Ensis shell, Astarte shell

1530 - Dredge in - underway to Station F
17 Arctica, 2 Cancer, 100-150 juvenile scallops, 6 adult scallops, 12 starfish, sponge, 8 bushels of shells

1735 - Dredge on board

1805 - On Station F - 37 fathoms - Loran 3300 2974

1820 - Shipek - 2 metals and 1 biological - Shipek wouldn't catch
Phytoplankton sample taken - Hydrocast surface, 22 m, 37 m, 67 m
Bt - surface temp. 10°

1914 - Zooplankton trawl

1925 - Trawl on bottom - 1 starfish, 1 skate

2030 - Underway to Station 24

2052 - On Station 24 - 30 fathoms - Loran 3305 2998 NE 18 knots

2100 - Shipek - 3 metals - sediment size - 5 biological
Odd sample - black Viscus layer about 2-1/2" thick on top of clean sand - Phytoplankton sample taken

2130 - Clam dredge

2230 - Trawl - underway to Station 25

2245 - On Station 25 - 41 fathoms - Loran 3345 2937 -
NE 10 knots - seastate 4 - wave hts. 4

2355 - Shipek - sediment size - 1 metal

March 13, 1974

0008 - Clam dredge, 1hr. - Zooplankton, 15 min.
Rocking chair, 1st haul 50 min. - winch stalled, dredge washed astern for 50 min. - Cancer, scallops, Arctica, Spisula shell, starfish

0155 - Commenced 2nd clam dredge

0240 - Rocking chair dredge, 2nd haul - starfish, Cancer, Arctica, scallop, 1 Rolling Rock bottle (good condition, no deposit-no return) Underway to Station 14 - wind direction changed NW, clear, cold, windy

0515 - Arrive Station 14 - 29 fathoms - Loran 3500 2968 WNW 40 knots hydrocast wire angle 35° - no bacti, bag broken - sea state very rough

0640 - Chair dredge over

0710 - Dredge onboard - little catch

0725 - Dredge overboard - underway to Station 19

1028 - Dredge over 1 mi. from Sta. 19 - small catch

1153 - Reset dredge w/following sea

1219 - Dredge onboard - regained station -

1230 - On Station 19 - 29 fathoms - Loran 3610 2997 - sea state 4 - wave ht. 8

1318 - Shipek - 3 biologicals, sediment size, pesticide, bacti

1400 - Hydrocast - 4.6 m, 22.9 m, 30.5 m, 55 m
BT - surface temp. 4°C - phytoplankton sample

1426 - Underway to Sta. 30

1550 - Dredge over - 1 mile from Station 30

1650 - Dredge up - catch poor

1710 - Second dredge haul

1740 - Dredge up - too rough for CB sampler or trawl

1800 - On Station 30 - 25 fathoms - Loran 3680 3010
Shipek - 2 replicates - 1 metal - 1 sediment size

1830 - Hydrocast - BT - surface temp. 8°C

1843 - Underway Station 29

1952 - Clam dredge over and fishing - SE of Sta. 29

2055 - On Station 29 - 25 fathoms - Loran 3630 3047 - NW 28-32 - rough and cold - clam dredge - 5 Arctica, Russian bottle

2115 - Shipek drops - 1 metal - phytoplankton sample taken

2145 - Underway for Station 28

2337 - Slow to tow dredge - 1 mile SE from Sta. 28

2250 - Dredge towing

2320 - Hauling dredge - small catch, Limulus, flounder, skate, Arctica, Spisula, oyster shell (fossilized), sponge

2345 - Second clam dredge - underway

March 14, 1974 - towing dredge

0015 - Hauling dredge - good catch, 4 horseshoe crabs, 4 Arctica, 4 Polinices, sand dollars, skate, sponge, hermit crab, scallops, sand dab

0055 - On Station 28 - 22 fathoms - Loran 3580 3078 - WNW, 36 knots

0100 - Shipek - 2 metals, 1 sediment size, 2 biologicals
Phytoplankton sample taken - BT taken

0140 - Hydrocast - surface, 4.6 m, 21 m, 30.5 m, 42.7 m

0204 - Underway to Station 18

0257 - Dredge over

0303 - Dredge over and set

0405 - Dredge in - good catch, Arctica, hermit crab, skate, 4 spotted flounder, goosefish, scallops, mussels, starfish, limpet, Cancer, Polinices

0420 - On Station 18 - 24 fathoms - Loran 3555 3032 high winds - very rough, cold

0425 - Shipek - 2 metals, 1 biological - phytoplankton sample taken

0447 - Hydrocast

0415 - Underway to Station 21

0527 - Clam dredge over

0544 - Clam dredge set

0654 - Clam dredge up - good catch

0705 - On Station 21 - 25 fathoms - Loran 3490 3009 cold, windy, rough - Shipek - 2 biologicals, 1 metal Phytoplankton sample taken

0733 - Underway to Station 23

0805 - Clam dredge over - 1 mile NW of Station 23

0815 - Dredge set and fishing

0905 - Dredge aboard - bag open, needed repairs - made station while repairing dredge

0945 - On Station 23 - 32 fathoms - Loran 3445 2998 - NW 20 knots rough, windy, cold - Shipek - 3 replicates, 3 biologicals, 1 metal - phytoplankton sample - BT taken - surface temp. 9°C

1010 - Rocking chair dredge - repairs completed, over and fishing

1050 - Rocking chair hauled - good catch, scallops, Arctica, skate, flounder, Cancer

1100 - Trawl over - following sea

1200 - Trawl aboard - 2 sea robins, starfish, small scallops, juvenile fish, sand dollars

1215 - Underway to Station 2 to retrieve current meters

1910 - Underway to Station 20

1940 - Dredge over and set - steaming toward Station 20

2040 - Dredge aboard

2045 - On Station 20 - 23 fathoms - Loran 3430 3060 - weather moderating - Shipek - 5 replicates - 2 metals, 5 biologicals Phytoplankton sample taken

2107 - Underway to Station 22

2143 - Dredge over and set

2230 - Dredge up - needed second run

2300 - Hauling dredge

2318 - Dredge aboard - huge catch - dredge full

March 15, 1974

0003 - On Station 22 - 26 fathoms - Loran 3345 3053

Shipek - 6 biologicals, 3 metals, 1 sediment size (taken because there was very coarse gravel present - very different from other samples -- 1 very dark sample taken)

Hydrocast - surface, 10 m, 20 m, 35 m bacti taken

BT - surface temp. 6°C

0011 - Underway to Station E

0037 - Dredge over

0150 - Dredge aboard

0207 - On Station E - 23 fathoms - Loran 3351 3025

Shipek - 5 replicates 1 metal, 5 biologicals - bottom water sample taken - phytoplankton sample taken

0230 - Dredge over for second haul

0330 - Dredge in - Limulus, Polinices, flounder, goosefish, scallops, Arctica

0335 - Trawl over and fishing

0357 - Trawl aboard - Spisula, Arctica, scallop and Polinices shells

0400 - Underway to Station 8 to resample with dredge

0435 - Dredge out and fishing

0543 - Dredge up - underway to retrieve current meters Station C

0700 - Lifeboat lowered to retrieve current meter array

0815 - Retrieved current meters - calm NW 2-4 - clear, cold

0850 - Trawled thru discolored water, presumably acid dump - pH meter inoperative

0945 - Trawl aboard - many live sand dollars, 1 squid, starfish, small skate - trawl line parted in winch

1000 - Secured oceanographic operations - Underway to Lewes, Delaware

OPERATION "IDES"
R/V Advance II
SHIP's LOG

Date: 3-11-74

Time	Position 3 H4	 3 H5	Comments
0330	3411	3150	
0428	3451	3114	Buoy R "F" @ 4.8
0500	3472	3094	
0538	3500	3074	
0600	3502	3066	R "F" 12.8
0730	3468	3066	
0745			
0805	3512	3065	Stop for Sta. A
0830	3507	3066	
0900	3504	3065	
0944	3523	3064	Towing dredge
1000	3508	3064	
1025	3512	3065	Stop to haul dredge
1100	3491	3057	Underway
1130	3438	3043	
1145	3420	3043	Stop for Sta. C
1215	3414	3042	Stop for Sta. C
1240	3410	3041	Stop for Sta. C
1258	3407	3041	Current meter over Del. buoy
1308	3407	3040	Del.buoy 256°T @ 12.6 mi.

Date 3-11-74

Time	3 H4	3 H5	Comments
1315	3407	3040	Recov. Sta. C tow scallop dredge
1400	3426	3045	Recov. plankton net
1407	3420	3043	Sta. C end of plankton tow & scallop dr.
1430	3416	3042	Otter trawl over
1455	3428	3044	Haul otter trawl
1509	3425	3044	Underway Sta. B
1530	3393	3051	Underway Sta. B
1537	3395	3053	Sta. B
1608	3394	3050	Underway rocking chair dredge/plankton
1642	3418	3049	Tow completed
1710	3417	3050	Underway for Sta. D
1727	3405	3041	Current buoys to port 1/8 mile
1730	3403	3039	
1745	3401	3030	Sta. D 17 fathoms
1755			Dredge on bottom
1837	3393	3031	Dredge off bottom
1847	3391	3032	Regaining station
1900	3401	3032	Sta. D
1918	3402	3033	Trawling
1950	3885	3027	
2000	3384	3027	
2030	3356	3013	
2039	3356	3009	Stop for Sta. 2

Date 3-11-74

Time	Position 3 H4	 3 H5	Comments
2102	3358	3010	
2106	3358	3009	Current meter
2130	3358	3011	
2200	3364	3009	Towing dredge
2230	3361	3013	
2239	3353	3012	Stop to haul dredge
2300	3349	3012	
2330	3361	3012	
0015	3359	3015	Towing trawl
0025	3364	3014	Haul net
0050	3365	3013	Regaining Sta. 8
0103	3361	3008	Sta. 8 (Sta. not regained precisely due to current meter location)

Date 3-12-74

Time	3 H4	3 H5	Comments
0115	3359	3006	Sta. 8
0130	3358	3007	
0158	3355	3006	Underway for plankton tow & scallop dredge
0215	3365	3006	u/w for plankton tow & scallop dredge
0230	3359	3011	u/w for plankton tow & scallop dredge
0237	3352	3012	Stop - haul dredge
0255	3350	3013	Underway to Sta. 9 - course 250°
0300	3344	3014	u/w to Sta. 9 - course 250°

Date 3-12-74

Time	Position 3 H4	 3 H5	Comments
0330	3284	3028	Underway to Sta. 9 - course 250°
0403	3222	3044	" " " " "
0418	3217	3051	Sta. 9
0500	3212	3051	Dredge on bottom
0540	3235	3053	Dredge off bottom
0605	3227	3055	Trawl on bottom
0650	3183	3053	Trawl off bottom - u/w to Sta. 17
0735	3181	3030	Sta. 17
0800	3177	3031	" "
0830	3180	3034	" "
0900	3152	3029	" "
0930	3117	3018	" "
0935	3110	3017	Stop Sta. 26
1010	3103	3018	Underway towing dredge
1030	3106	3019	Dredge overboard
1200	3105	3019	Towing net
1230	3119	3019	" "
1236	3120	3019	Haul net
1255	3116	3020	Net aboard - proceed to Sta. 27 course 090°
1330	3148	2999	" " " " " "
1400	3175	2982	" " " " " "
1415	3182	2974	Sta. 27

Date 3-12-74

	Position		
Time	3 H4	3 H5	Comments
1430	3175	2975	Sta. 27
1440	3173	2975	Dredge over
1500	3180	2975	" "
1517	3187	2974	Haul dredge
1530	3187	2974	Dredge in - proceed to Sta. F
1600	3236	2974	" " " " "
1658	3300	2974	Sta. F
1700	3300	2974	" "
1755	3304	2974	Dredge on board - regaining Sta. F
1805	3300	2974	Sta. F
1837	3287	2970	Underway to regain Sta. F
1854	3305	2974	Sta F regained (allowing for set)
1907	3301	2974	Setting trawl
1922	3309	2974	Trawl on bottom
2000	3333	2976	" " "
2030	3319	2985	" " "
2052	3305	2998	Stop for Sta. 24
2101	3304	3036	
2106	3301	2998	
2130	3303	3000	Towing dredge
2200	3306	2997	" "
2203	3304	2997	Hauling in dredge
2216	3288	2998	Dredge aboard

Date 3-12-74

	Position		
Time	3 H4	3 H5	Comments
2230	3302	2990	
2300	3333	2970	
2330	3350	2948	

Date 3-13-74

0000	3245	2937	Sta. 25
0008	3341	2937	Dredge & Plankton tow
0030	3349	2938	" " "
0100	3345	2944	" " "
0107	3344	2941	Clam dredge
0148	3345	2933	Commence 2nd dredge tow
0200	3346	2934	
0225	3349	2939	Clam dredge
0240	3349	2942	Dredge aboard - depart for Sta. 14
0300	3371	2950	
0330	3409	2956	
0400	3443	2960	
0430	3472	2960	
0445	3480	2962	
0512	3500	2968	Sta. 14
0555	3493	2966	Messenger
0637	3497	2966	Dredge on bottom
0708	3502	2967	Dredge off bottom
0724	3505	2968	Dredge on bottom

Date 3-13-74

Time	Position 3 H4	 3 H5	Comments
0800	3515	2969	
0830	3521	2969	
0900	3530	2984	
0930	3551	2997	
1000	3588	2996	
1018	3598	2996	Dredge on bottom 1 mi. from Sta. 19
1038	3604	2995	
1100	3611	2996	On Sta. 19 towing dredge
1134	3618	2997	" " " " "
1200	3610	2995	" " " " "
1219	3595	2991	Clam dredge
1240	3581	2988	Dredge aboard - regain sta.
1318	3610	2997	Regain Sta. 19
1400	3618	2997	Hydrocast
1426	3613	2993	Proceed to Sta 30
1500	3643	2999	
1530	3693	3007	
1539	3682	3008	Dredge over
1544	3684	3009	Dredge set - Sta. 30
1655	3723	3021	Dredge up - underway Sta. 30
1708	3717	3018	Dredge set
1743	3694	3009	Dredge up
1755	3680	3010	Sta. 30
1810	3682	3009	Comp. grabs - commence hydrocast

Date 3-13-74

Time	Position 3 H4	 3 H5	Comments
	3690	3013	Underway for Sta. 29
1900	3676	3022	
1930	3652	3038	
1952	3625	3044	Dredging Sta. SE Sta. 29
2005	3630	3046	Towing dredge on Sta. 29
2030	3639	3046	
2055	3642	3046	Dredge aboard
2100	3641	3047	
2115	3630	3048	Grab down
2142	3636	3048	Complete Sta. 29 - underway Sta. 28
2200	3624	3053	
2230	3585	3066	
2237	3580	3069	Slow to tow dredge 1 mi. SE Sta. 28
2250	3580	3069	Dredge set
2300	3579	3072	
2311	3580	3075	Sta. 28 towing dredge - course 305°
2320	3580	3078	Hauling dredge
2342	3580	3080	Turn for second dredge tow
Date 3-14-74			
0000	3583	3074	
0020	3582	3070	Clam dredge

Date 3-14-74

Time	Position		Comments
	3 H4	3 H5	
0033	3578	3070	Clam dredge up - regain Sta. 28
0054	3580	3078	Sta. 28 - Shipek
0140	3582	3076	Hydrocast
0204	3582	3076	Underway for Sta. 18
0230	3583	3057	Dredge over
0257	3563	3039	Dredge over
0303	3558	3035	Dredge set - towing across Sta. 18
0330	3554	3029	
0405	3555	3034	Dredge in
0425	3555	3032	Sta. 18 - grab
0447	3559	3031	Hydrocast
0451	3561	3031	Underway for Sta. 21
0514	3536	3021	
0527	3500	3012	Dredge Sta. - course 170° true - 1/3 spd.
0544	3495	3011	Dredge set
0654	3485	3009	Dredge up
0703	3490	3009	Sta. 21 - grab - hydro
0733	3494	3011	Underway for Sta. 23
0805	3445	3003	Dredge over 1 mi. NW Sta. 23
0815	3445	2999	Dredge set
0900	3446	2991	Towing dredge
0905	3448	2998	Dredge aboard
1010	3449	2997	Dredge over
1022	3445	2998	Towing dredge on Sta. 23

Date 3-14-74

Time	Position		Comments
	3 H4	3 H5	
1057	3444	3009	Dredge aboard
1100	3445	3009	Trawl over 1.5 mi. NW Sta. 23 - C 124 T
1129	3445	2998	Towing trawl on Sta. 23
1200	3447	2987	C/H trawl
1215	3445	2986	Trawl aboard - underway Sta. 2
1230	3426	2989	
1330	3358	3008	Retrieving current meter, Sta. 2
1500	3364	3004	Meter aboard - underway Sta. 2
1530	3379	3018	
1612	3407	3039	Second meter
1907	3407	3040	Buoy over marking current meter
1910	3407	3040	Underway for Sta. 20
1940	3412	3047	Dredge set
2040	3430	3057	Dredge aboard
2045	3430	3060	All stop Sta. 20
2100	3427	3060	
2107	3421	3054	Underway
2143	3373	3053	Dredge over & set
2200	3359	3053	
2213	2245	2053	Sta. 22
2230	3331	3054	
2300	3336	3053	Hauling dredge
2318	3345	3053	Dredge aboard - on Sta. 22

Date 3-15-74

Time	Position		Comments
	3 H4	3 H5	
0003	3350	3042	Hydrocast complete - BT cast
0011	3342	3049	Underway to Sta. E
0037	3350	3030	Rocking chair dredge over- C 125°
0100	3351	3022	
0128	3347	3015	c/c to 305°
0130	3346	3019	
0144	3347	3023	c/h dredge
0150	3349	3024	Dredge aboard
0207	3351	3025	Sta. E - Shipek
0230	3348	3023	Finish hydro - dredge over
0240	3353	3023	Dredge set
0335	3342	3022	c/h trawl
0347	3352	3024	Trawl aboard
0400	3355	3024	Underway to Sta. 8
0415	3330	3016	
0435	3301	3014	Dredge out
0437	3301	3014	Dredge set
0500	3319	3016	Sta. 8
0543	3350	3020	Dredge up - underway for current meter station
0700-0815	3407	3040	Retrieved current meter and anchor
0830-0945	3400	3037	Trawl

Environmental Protection Agency
Region III
Annapolis Field Office
Annapolis Science Center
Annapolis, Maryland 21401

OPERATION "IDES"

Cruise Plan

March 11-15, 1974

OPERATION "IDES"

March 1974

Ocean dumping operations on the continental shelf off Delaware and Maryland show evidence of elevated concentrations of potentially toxic metals in the sediments and biota, as determined from survey cruises to the area.

The spring 1974 cruise was designed with the objectives:

1. Extend monitoring observations of environmental conditions at previously observed locations.

2. Expand observations to delineate affected depositional areas.

3. Develop statistical comparisons of affected and unaffected areas.

4. Expand circulation information with current meter array.

5. Incidentally gather baseline data of environmental conditions at potential oil drilling sites. These are normal reference stations for ocean dumping monitoring.

6. Collect indigenous organisms for bioassay development in the laboratory.

Rationale:

The vagaries and uncertainties of early spring weather indicate the desirability of establishing priorities of stations and sampling.

Accordingly, 10 stations have been assigned priority over the remaining stations, and sediment retrieval and benthic animal collection given sampling priority.

Operation "IDES"

Stations

Station Sequence	Priority	Latitude	Longitude	3H4	3H5
A	1	38°40.6' N	74°19.5' W	3512	3065
19	1 (approx)	38°40.7' N	74° 0.0 W	3610	2996
14	1	38°27.8' N	73°57.0' W	3500	2968
C	1	38°31.2' N	74°19.5' W	3420	3043
B	1	38°35.1' N	74°18.1' W	3440	3048
D	1	38°28.5' N	74°17.0' W	3401	3030
2	1	38°22.3' N	74°14.2' W	3356	3009
8	1	38°20.7' N	74°19.0' W	3313	3018
9	1	38°11.9' N	74°32.9' W	3217	3051
17	2	38°12.1' N	74°28.3' W	3181	3030
26	1 (approx)	38°05.2' N	74°27.7' W	3110	3017
27	2 (approx)	38°05.2' N	74°13.4' W	3182	2974
F	1	38°13.6' N	74°08.7' W	3300	2985
25	2 (approx)	38°13.0' N	73°57.8' W	3346	2936
24	2 (approx)	38°17.0' N	74°14.5' W	3305	2998
E	2	38°23.5' N	74°18.2' W	3350	3025
23	2 (approx)	38°28.0' N	74°08.0' W	3445	2998
21	2 (approx)	38°32.8' N	74°08.5' W	3490	3009
18	2 (approx)	38°40.6' N	74°10.5' W	3557	3032
20	2 (apporx)	38°34.2' W	74°22.8' W	3430	3060
22	2 (approx)	38°27.2' N	74°26.0' W	3345	3053

OPERATION "IDES"

Watch List

PORT WATCH	STARBOARD WATCH
1. Smith	1. O'Malley
2. Thomas	2. Lear
3. Pesch	3. Meyers
4. Downing	4. Reynolds
5. Davis	5. Crutchley
6. Yff	6. Williams
7. Bailey	7. Kafka
8. Muir	8. Steibolt
9.	9. McCleary

OPERATION "IDES"

STANDARD STATION	PORT WATCH	STARBOARD WATCH
1. Niskin sampler	Smith	O'Malley
1. Bacti	"	"
2. Shipek 6 replicates	Bailey, Thomas	Crutchley, Lear
1. Bacti	Smith	O'Malley
2. Metals	"	"
3. Particle size	"	"
4. PCB's, Pesticides	"	"
5. Organisms	"	"
6. TOC	"	"
3. Probe readings (Sal., Cond., Temp., DO, pH)	Davis, Downing	Meyers, Kafka
4. Hydrocast	Muir, Yff	Williams, McCleary
1. Metals (Sta. 2 only)	" "	" "
2. Fe & Nutrients	" "	" "
3. TOC (Bottom H_2O's only)	" "	" "
5. Phytoplankton grab (surface water only)	" "	" "
1. I.D.		
6. Zooplankton tow	Davis, Muir	Kafka, Meyers
1. I.D.		
2. Metals		
7. Trawl	Bailey, Thomas	Crutchley, Lear
1. Organisms		
2. Metals		
8. Rocking Chair Dredge	Pesch, Downing	Reynolds, Steibolt
1. Organisms		
2. Metals		

Operation "IDES"

Station Routine

A. ANCHORED

1. Shipek - 6 drops
    - a. Bacti - sediment - process @ station
    - b. Chemistry
        - (1) PCB - glass jar - store
        - (2) Metals - whirlpak
        - (3) Sediment size - whirlpak
        - (4) TOC - whirlpak
    - c. Biology (5 replicates) gal. jars with buffered formalin (5%)
2. Hydrocast
    - a. Niskin - bottom H_2O
        - (1) Bacti MPN
    - b. Van Dorn bottles or submersible pump (surf.)
        - (1) Metals (Sta. 2 bottom only) gal cubi - freeze
        - (2) Fe & nutrients (water col. & bottom waters) qt. cubi - freeze
        - (3) TOC - whirlpak - freeze
        - (4) Phytoplankton grab - fix - Lugol's soln.

B. UNDERWAY

- a. Rocking chair clam dredge
    - (1) I.D. and count organisms
    - (2) Freeze representative species for metals
- b. Trawl
    - (1) I.D. and count organisms
    - (2) Freeze representative species for metals
- c. Zooplankton tows (2)
    - (1) I.D. - preserve
    - (2) Metals - freeze

Operation "IDES"

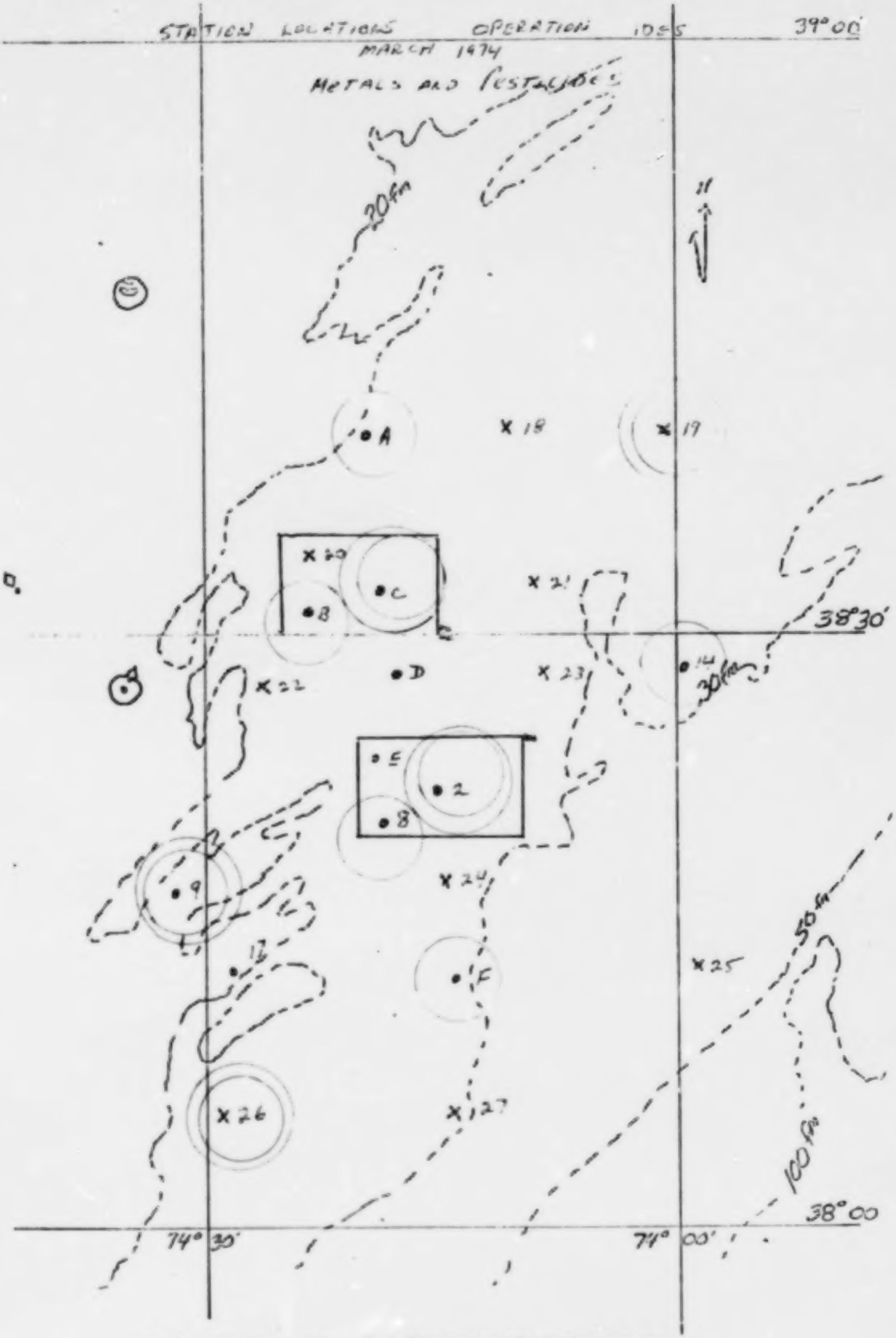
March 11-15,1974

Parameter	Sampler	Sample # Per Station	Max # Sampler	# Analyses	Container	Preservative	Analyst	Data Inter.
SEDIMENTS								
Bacti	Shipek	1	8	8	Fr. Sq.	Process	AFO	AFO
PCB's, Pesticides	"	1	5	5	Pt. Mason	Stow	AFO	AFO
TOC	"	1	7	7	Glass	Freeze	AFO	AFO
Metals	"	5		400	Whirlpak	"	AFO	AFO
Sed. Size	"	1	5	5	Jar	Stow	AFO	AFO
Biology	"	5	105	105	Gal.Mason	5% Formalin	AFO	AFO
WATER								
Bottom Bacti	Niskin	1	8	8	Fr. Sq.	Process	AFO	AFO
Bottom Metals	Van Dorn	1	1	1	Gal.cubi	Freeze	Corvallis?	
Bottom TOC	"	1	8	8	Whirlpak	"	AFO	AFO
Bottom Fe & Nut.*	"	1	8	40	Qt. cubi	"	AFO	AFO
Water Col. & Nut.*	"	4	20	100	Qt. cubi	"	AFO	AFO
BIOLOGY								
Organisms								
Metals	Rocking Chair	1/20			Plastic bags	Freeze	Narra.	Narra.
Metals	Trawl				Plastic bags	Freeze	AFO	AFO
PHYTOPLANKTON								
I.D.	Grab	1	20	20	Fr. Sq.	Formalin	AFO	AFO
ZOOPLANKTON								
I.D.	Tow	2	8	8	Glass	Formalin + Hexo.	AFO	AFO
Metals	Tow	2	8	80	Whirlpak	Freeze	AFO	AFO

* Nutrients: Total PO as PO_4, Inorganic PO_4, TKN, NO_2+NO_3

"IDES"

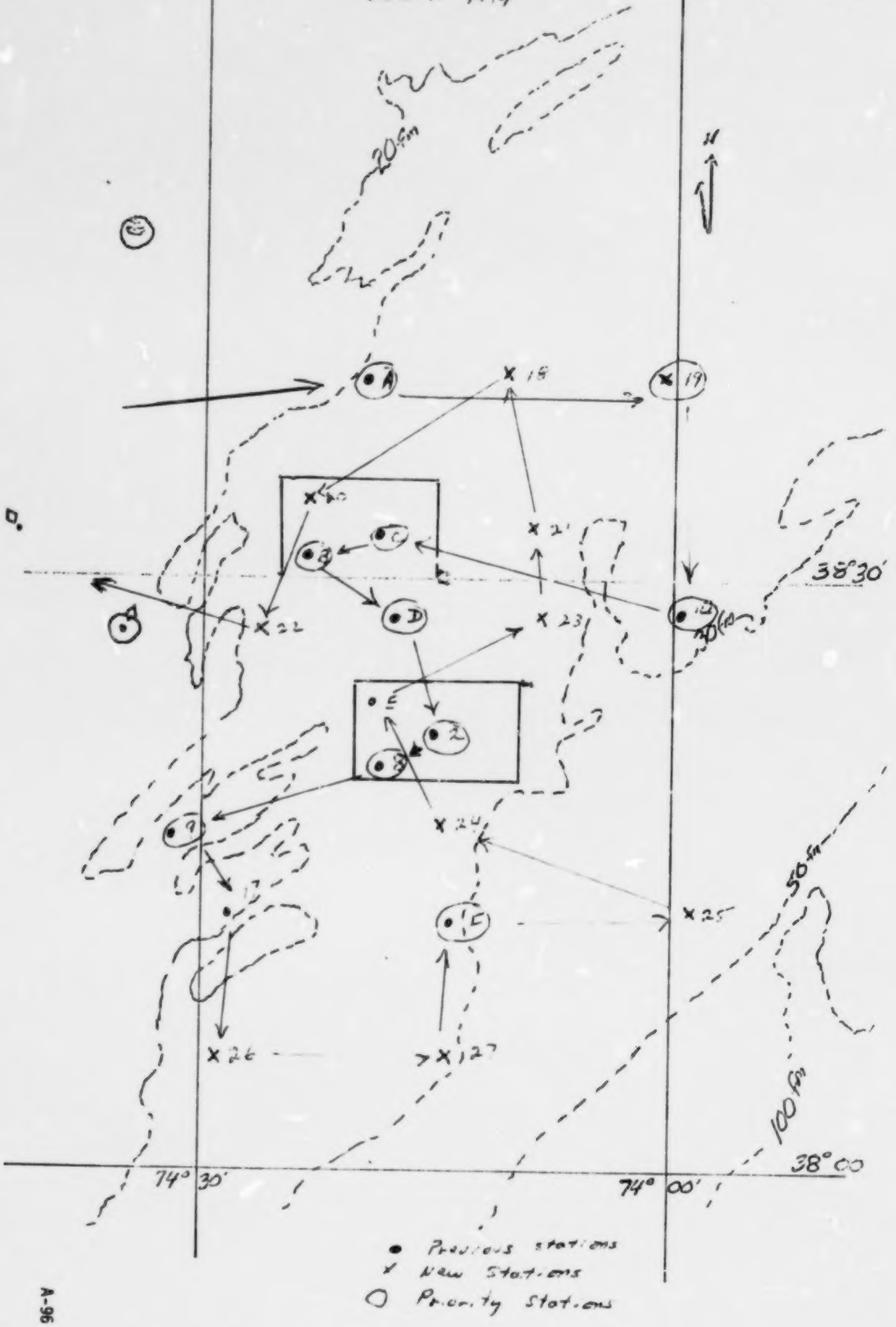
		Bottom Water					Sediments									
Sta.	Hydrocast (Profile)	Bacti	Nutrients	Metals	TOC	Water Col. Fe & Nut.	Bacti	TOC	Pest.	Metals	Sed. Size	Biology	Trawl	Dredge	Phyto Grab	Zoop Tow
A	x									5-5-1-5		5		x	x	
19		x	x		x		x	x	x	5-5-1-5	x	5	x	x	x	2
14	x	x	x		x	x	x	x		5-5-1-5		5	x	x	x	2
C	x	x	x		x		x	x	x	5-5-1-5	x	5	x	x	x	2
B										5-5-1-5		5		x	x	2
D										1-10		5	x	x	x	
2	x	x	x	x	x	x	x	x	x	5-5-1-5	x	5	x	x	x	2
8		x	x		x	x	x	x		5-5-1-5		5		x	x	2
9		x	x		x	x	x	x	x	5-5-1-5		5	x	x	x	2
17										1-10		5		x	x	
26		x	x		x	x	x	x	x	5-5-1-5	x	5	x	x	x	2
27										1-10		5		x	x	
F	x									5-5-1-5		5		x	x	
25										1-10	x	5		x	x	
24										1-10		5		x	x	
E		x	x		x		x			1-10		5		x	x	
23										1-10		5		x	x	
21										1-10		5		x	x	
18										1-10		5		x	x	
20										1-10		5		x	x	
22										1-10		5		x	x	

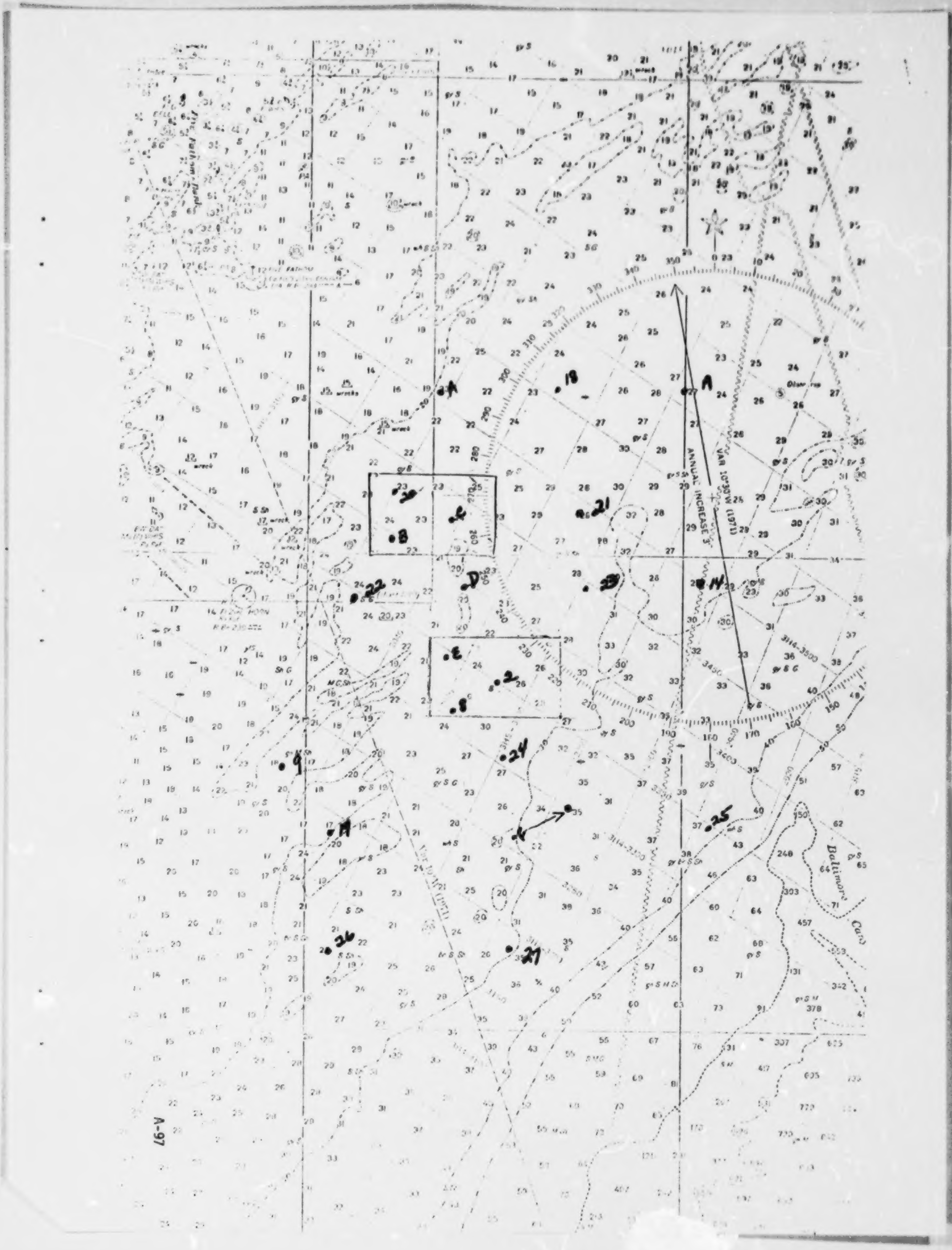

STATION LOCATIONS OPERATION 10SS
MARCH 1974
METALS AND PESTICIDES

39°00'
20 fm
N
A
x 18
x 19
x 20
C
B
x 21
38°30'
x 22
D
x 23
14
30 fm
E
2
8
9
x 24
12
F
x 25
50 fm
x 26
x 27
100 fm
38°00
74° 30'
74° 00'

Fe, Hg, Cr, Pb, and Zn - 5 replicates on 10 circled stations
Other five metals determined once on circled stations
All 10 metals determined once on remaining stations
Pesticides - once at double circled stations

STATION LOCATIONS OPERATION IDES
MARCH 1974


39°00'
38°30'
38°00'
74° 30'
74° 00'
N
20 fm
40 fm
50 fm
100 fm
A
x 18
x 19
x 20
B
C
x 21
x 22
D
x 23
12
E
2
3
9
x 24
13
15
x 25
x 26
x 27
• Previous stations
x New Stations
○ Priority Stations


A
B
C
D
E
18
21
22
23
14
9
17
24
25
26
27
2
8
VAR 10°30'W (1971)
ANNUAL INCREASE 3'
Baltimore
Can

APPENDIX B

OPERATION ."DEEP SIX"

USCG "Alert" MEC 630 - 12-15 August 1974

DATA REPORT

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OPERATION "DEEP SIX"

DATA REPORT

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Benthic Infauna Populations*

Cruise Plan B-58

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OPERATION "DEEP SIX"

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OPERATION "DEEP SIX"

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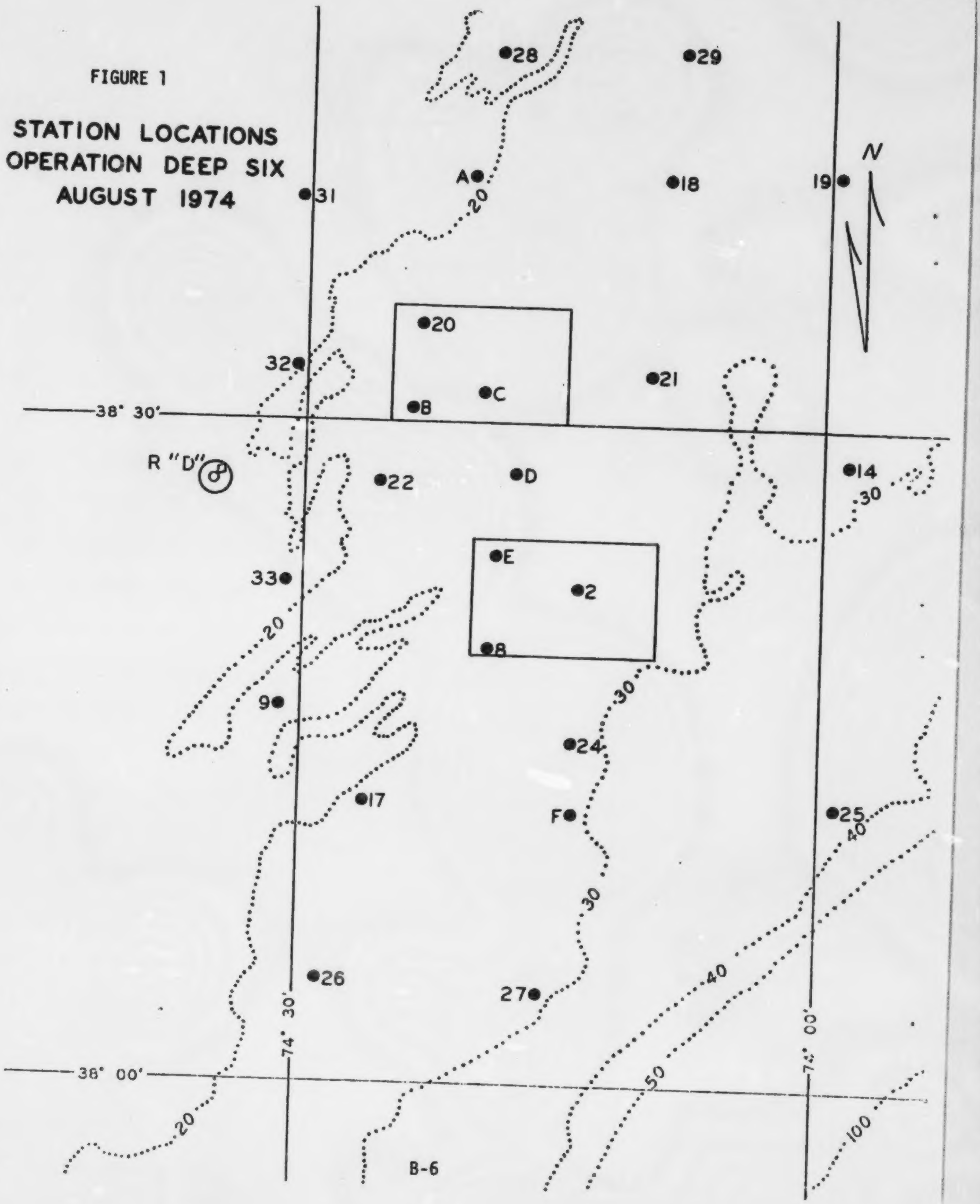
Table 1

OPERATION "DEEP SIX" - STATION DATA

			Loran A		Loran C				
Sta.	Date	Time	3H4	3H5	SS7-Y	SS7-Z	Lat.	Long.	Depth Meters
							W	N	
31	8-12-74	1243	3444	3104	-------	-------	74°32.4'	38°40.5'	31
32	"	1938	3363	3081	-------	-------	74°31.8'	38°32.2'	31
22	8-13-74	0015	----	----	52257.0	70430.5	74°25.8'	38°26.5'	40
E	"	0550	----	----	52239.7	70465.4	74°19.0'	38°23.3'	38
2	"	1225	----	----	52216.3	70474.0	74°15.3'	38°23.0'	44
8	"	1415	----	----	52273.3	70488.8	74°18.8'	38°19.6'	44
24	"	1745	3290	2996	-------	-------	74°14.3'	38°15.7'	44
25	"	2325	3339	2938	-------	-------	73°58.5'	38°12.5'	69
F	8-14-74	0553	3264	2985	-------	-------	74°12.7'	38°13.7'	57
27	"	0852	3167	2976	-------	-------	74°14.8'	38°04.3'	53
26	"	1308	3115	3018	-------	-------	74°28.3'	38°05.7'	38
17	"	2023	3176	3028	-------	-------	74°28.8'	38°10.6'	36
9	8-15-74	0055	3219	3047	-------	-------	74°30.7'	38°17.1'	36
33	"	0235	3270	3064	-------	-------	74°32.5'	38°23.0'	31
D	"	0821	3396	3033	52188.2	70441.3	74°18.3'	38°28.2'	36
B	"	1225	3397	3050	-------	-------	74°22.6'	38°30.5'	40
20	"	2112	3432	3060	-------	-------	74°22.6'	38°34.4'	53
C	"	1735	3430	3044	-------	-------	74°19.2'	38°32.5'	44
21	"	2252	3480	3012	-------	-------	74°09.4'	38°32.2'	38
14	8-16-74	0331	3553	2960	-------	-------	73°54.7'	38°32.2'	57
19	"	1055	3602	2997	-------	-------	74°00.2'	38°40.0'	46
18	"	1235	3562	3034	-------	-------	74°09.8'	38°41.3'	40
A	"	1745	3517	3064	-------	-------	74°19.8'	38°41.4'	35
28	"	2150	3577	3080	-------	-------	74°20.3'	38°46.7'	35
29	8-17-74	0150	3641	3042	-------	-------	74°08.3'	38°48.3'	44
Special	"	0630	3480	3130	-------	-------	74°37.8'	38°47.2'	--

FIGURE 1

STATION LOCATIONS
OPERATION DEEP SIX
AUGUST 1974


28
29
A
20
31
18
19
N
20
32
21
B
C
38° 30'
R "D"
22
D
14
30
E
33
2
20
8
30
9
24
17
F
25
40
30
26
40
27
74° 30'
74° 00'
38° 00'
50
20
100

OPERATION "DEEP SIX"

HYDROGRAPHY

The hydrographic data indicate the thermocline was well developed at all stations during this cruise and was found at approximately 16 to 20 meters. The weather was calm during this whole cruise, consequently no perturbations due to wind stresses would be expected.

The salinity distributions on this cruise show, at the surface, the influence of 33 parts per thousand coming in from the west, presumably due to the influence of the Delaware estuary. From the east side, a very pronounced tongue of 35 parts per thousand water at the surface, from the slope, intrudes and it would appear from the irregular distributions of salinity that this whole region is one of mixing of estuarine and outer shelf, possibly slope, waters (Figure 2). The U. S. Naval Oceanographic Office publication, "The Gulf Stream", published monthly, indicates that in July 1974 there were well defined anticyclonic eddies to the east of this area. The influence of these eddies, which were noted for the past six or eight months, on the distribution of temperature and salinity in this area, is as yet not known.

Table 2

OPERATION "DEEP SIX"

Hydrographic Data

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
2	8/13/74	1225	Surface	23.16	34.8	8.0
			5	23.10	34.8	-
			10	22.91	34.8	8.0
			15	22.40	-	-
			20	11.00	40.1	-
			25	9.36	34.9	-
			30	9.44	35.1	7.8
			35	9.24	34.8	-
			40	-	-	7.8
8	8/13/74	1415	Surface	22.90	33.9	8.0
			5	22.54	34.0	7.8
			10	22.58	34.4	-
			15	14.16	34.5	-
			20	9.67	34.9	-
			25	9.76	35.3	-
			30	9.51	35.1	-
			35	9.26	35.0	7.8
			40	9.19	35.0	-
			43	-	-	7.8

OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
9	8/15/74	0055	Surface	22.9	33.5	8.2
			5	23.1	33.4	-
			7	-	-	8.0
			10	22.5	33.5	-
			15	19.5	33.7	-
			20	11.5	34.4	-
			25	10.5	34.6	-
			30	10.6	34.5	-
			31	-	-	7.9
			35	10.4	34.6	-
			39	-	-	7.9
14	8/16/74	0331	Surface	23.46	34.8	8.2
			5	23.51	35.2	-
			10	23.40	35.1	-
			12	-	-	8.2
			15	22.98	34.9	-
			20	21.92	36.2	-
			30	10.49	35.4	-
			40	7.	35.3	8.0
			48	-	-	8.0
			50	7.51	35.0	-

OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
17	8/14/74	2023	Surface	23.24	32.7	8.1
			5	23.08	32.7	8.2
			10	22.52	32.6	-
			15	13.80	33.7	-
			20	11.50	33.5	-
			25	10.74	33.5	-
			30	10.63	33.9	8.3
			35	10.02	34.0	-
			36	-	-	7.8
18	8/16/74	1235	Surface	23.9	35.1	7.5
			5	23.6	34.3	-
			10	23.0	34.3	-
			12	-	-	7.6
			15	22.5	34.4	-
			20	15.8	35.3	-
			25	13.2	34.9	-
			30	12.6	35.4	-
			35	9.4	35.9	-
			37	-	-	7.5
			40	9.2	35.3	7.6

OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
19	8/16/74	1055	Surface	23.8	34.1	7.8
			5	23.3	34.1	-
			8	-	-	8.0
			10	23.3	34.1	-
			15	22.3	34.2	-
			20	14.7	35.0	-
			25	10.7	34.5	-
			30	8.2	34.6	-
			35	8.0	34.7	-
			38	-	-	7.85
			40	8.2	34.5	-
			43	-	-	7.8
20	8/18/74	2112	Surface	23.1	33.9	7.8
			5	23.0	34.1	-
			8	-	-	7.6
			10	22.5	33.9	-
			15	21.3	33.9	-
			20	13.5	34.0	-
			25	11.5	34.3	-
			27	-	-	7.4
			30	10.8	34.6	-
			35	10.3	34.5	-
			36	-	-	7.4

OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
21	8/15/74	2252	Surface	23.4	34.2	7.9
			5	23.4	34.3	
			10	23.3	34.7	
			11	-	-	7.9
			15	23.1	34.8	
			20	23.6	35.6	
			25	16.4	35.5	
			30	14.8	35.3	
			34	-	-	7.9
			35	11.4	34.8	
			40	8.6	34.8	
			46	-	-	7.9
22	8/13/74	0425	Surface	22.2	33.2	8.0
			5	21.9	33.4	-
			8	-	-	7.8
			10	22.1	33.4	-
			15	20.6	34.4	-
			20	11.7	34.4	-
			25	11.3	34.5	-
			27	-	-	7.8
			30	11.0	34.4	-
			38	-	-	7.8

OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
24	8/13/74	2134	Surface	23.6	35.1	8.1
			5	23.7	34.9	
			10	23.6	34.9	
			11.5	-	-	8.0
			15	23.5	35.2	
			20	23.1	35.1	
			23	-	-	7.7
			25	20.3	32.7	-
			30	14.5	35.1	-
			35	10.4	33.6	-
			40	8.5	34.9	-
			45	8.3	35.0	-
			49	-	-	7.7
25	8/14/74	0008	Surface	24.12	36.7	8.0
			5	23.94	37.0	-
			10	23.90	37.1	-
			15	-	-	8.0
			20	23.94	37.0	-
			25	23.86	36.9	-
			30	23.88	37.0	-
			35	23.30	36.6	-
			40	20.90	37.1	7.9
			83	-	-	7.8

OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
26	8/14/74	1612	Surface	23.71	32.8	8.0
			5	23.11	33.0	-
			10	23.23	33.6	7.9
			15	23.38	34.0	-
			20	14.54	33.9	-
			25	10.02	33.5	-
			30	9.69	34.0	7.6
			35	9.78	33.9	7.8
27	8/14/74	0925	Surface	23.8	34.4	7.9
			5	23.7	34.7	7.7
			10	24.0	35.0	-
			15	23.8	35.2	-
			20	20.0	35.5	-
			25	18.8	35.8	-
			30	15.2	35.0	-
			35	15.0	34.8	-
			40	10.1	34.1	-
			44	-	-	7.7
			45	8.4	34.1	-
			53	-	-	8.0

OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
28	8/16/74	2150	Surface	23.64	33.8	7.7
			5	22.88	33.4	-
			10	22.07	33.4	7.7
			15	22.12	33.9	-
			20	16.55	33.5	-
			25	12.84	34.2	-
			30	11.66	34.2	7.7
			42	-	-	7.7
29	8/17/74	0150	Surface	23.6	33.5	8.2
			5	23.2	33.5	-
			9	-	-	8.2
			10	23.0	33.6	-
			15	22.6	34.1	-
			20	13.3	34.1	-
			25	10.6	34.3	-
			30	10.3	34.4	-
			32	-	-	7.9
			35	10.1	34.6	-
			42	-	-	7.9

OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
31	3-12-74	1800	Surface	22.5	33.8	8.2
			5	22.4	33.2	-
			10	22.0	33.4	-
			15	16.1	34.0	-
			20	14.4	34.2	8.0
			25	14.2	34.2	-
			30	14.0	34.2	8.0
			35	14.0	34.1	8.0

OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
32	8/12/74	1938	Surface	22.70	33.9	8.2
			5	22.54	33.1	-
			10	21.92	33.5	8.2
			15	21.78	33.4	-
			20	14.77	33.8	-
			22	-	-	8.0
			25	13.81	34.2	-
			30	13.20	34.1	-
			35	13.11	34.2	8.0
33	8/15/74	0235	Surface	22.4	33.1	8.2
			5	22.5	33.6	-
			6	-	-	8.2
			10	20.5	34.1	-
			15	14.0	34.0	-
			20	12.2	34.2	-
			24	-	-	7.9
			25	11.6	34.3	-
			30	10.9	34.4	7.9

OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
A	8/16/74	1745	Surface	23.92	33.5	7.8
			5	23.30	33.9	-
			10	22.26	33.5	7.8
			15	21.34	33.7	-
			20	15.06	34.5	-
			25	12.19	34.3	-
			30	11.25	34.4	7.7
			34	-	-	7.6
B	8/15/74	1225	Surface	22.85	33.8	8.1
			5	22.69	33.6	8.2
			10	22.33	33.8	-
			15	20.94	34.0	-
			20	14.43	34.5	-
			25	11.47	34.8	-
			30	9.99	34.5	8.0
			35	9.84	34.6	8.0

OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
C	8/15/74	1735	Surface	24.2	34.3	7.8
			5	23.4	34.3	-
			8	-	-	8.0
			10	22.8	34.2	-
			15	22.3	34.3	-
			20	17.2	34.9	-
			25	10.5	34.5	-
			30	10.1	34.9	7.5
			35	10.0	34.5	-
			40	9.9	34.3	-
			44	-	-	7.5
D	8/15/74	0821	Surface	23.45	34.5	8.4
			5	23.32	34.5	8.4
			10	23.20	34.5	-
			15	23.16	34.2	-
			20	14.20	34.5	-
			25	9.71	34.5	-
			30	9.76	34.5	8.1
			35	9.66	34.6	8.2

OPERATION "DEEP SIX"

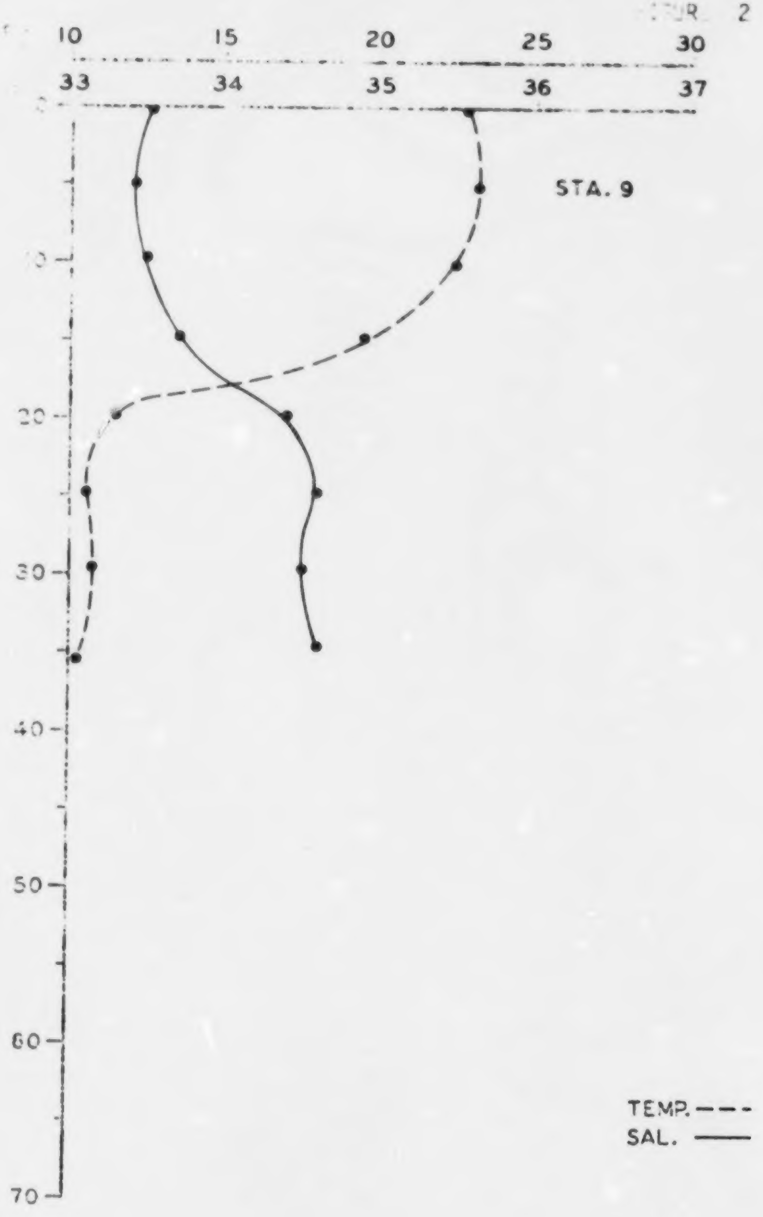
Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH	
D	8/15/74		Surface	-	-	7.8	(In discolored water)
			5m	-	-	7.8	
			16m	-	-	8.0	
			30m	-	-	8.0	
			35m	-	-	8.0	
E	8/13/74	0700	Surface	22.3	33.8	7.9	
			5	22.3	33.7	-	
			8	-	-	8.0	
			10	22.4	33.9	-	
			15	22.0	33.7	-	
			20	13.6	35.0	-	
			25	9.3	34.9	-	
			27	-	-	8.0	
			30	9.3	35.0	-	
			38	-	-	7.8	

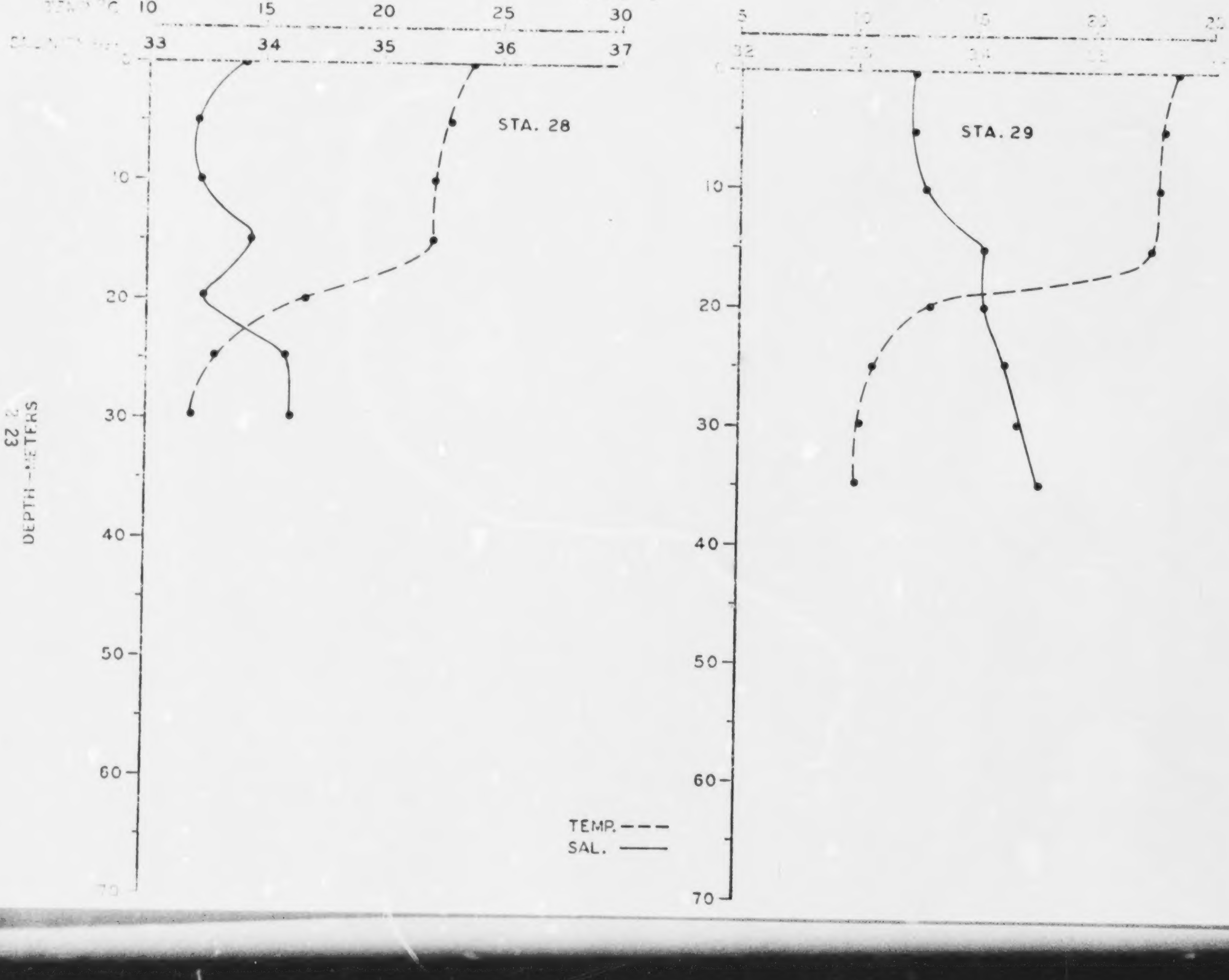
OPERATION "DEEP SIX"

Hydrographic Data (continued)

Station	Date	Time	Sample Depth	Temp.	Salinity	pH
F	8/14/74	0653	Surface	23.14	34.4	8.0
			5	23.68	34.8	-
			10	23.91	35.0	-
			15	23.68	35.5	-
			20	20.24	36.5	-
			25	15.33	35.0	-
			30	13.80	35.3	-
			35	8.83	35.2	-
			40	8.26	34.9	-
			50	8.45	34.9	8.1
			56	-	-	7.8

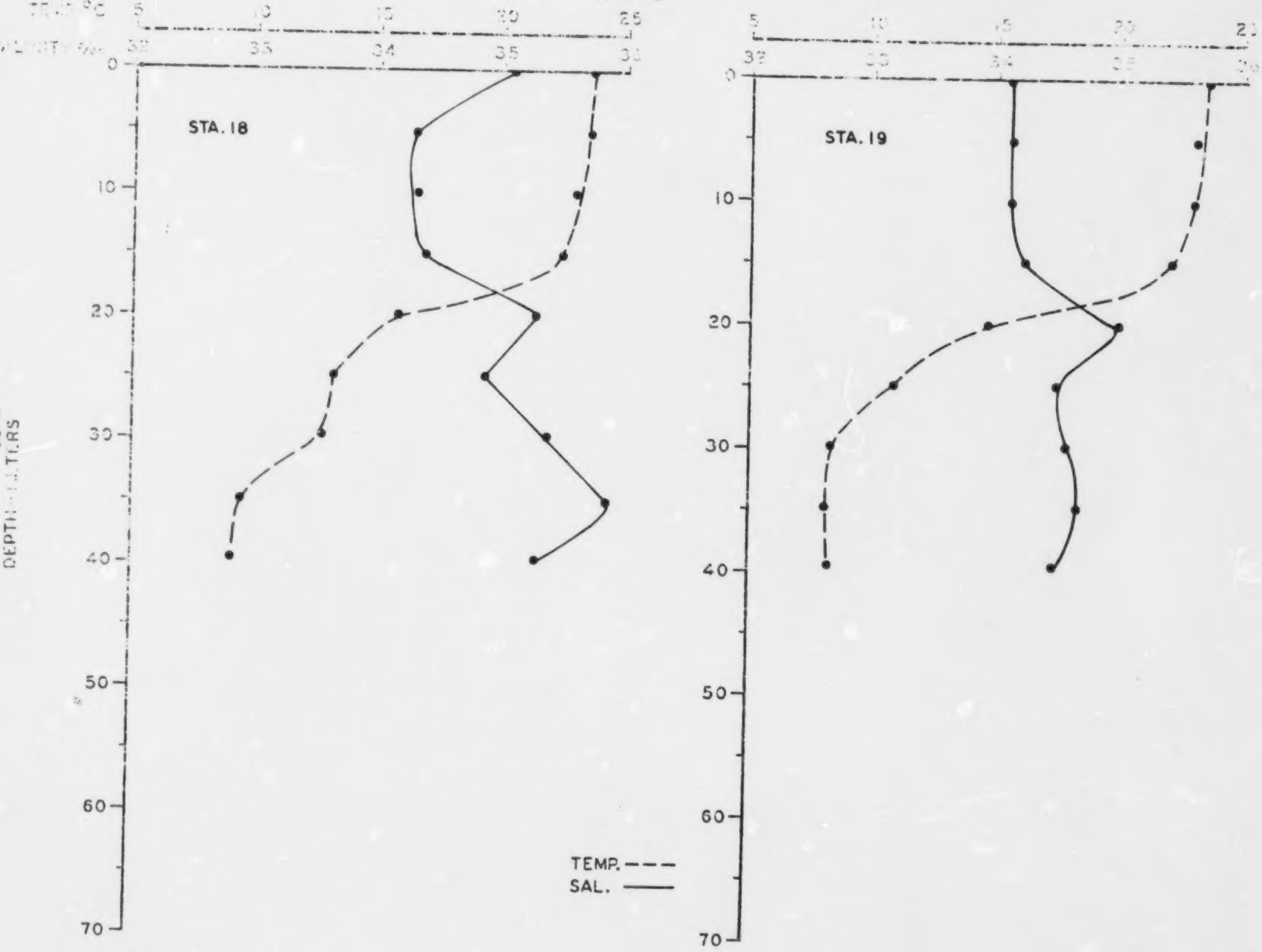

10
15
20
25
30
33
34
35
36
37
STA. 9
0
10
20
30
40
50
60
70
TEMP. ---
SAL. ——

TEMPERATURE-SALINITY PROFILES
OPERATION DEEP SIX
FIGURE 2



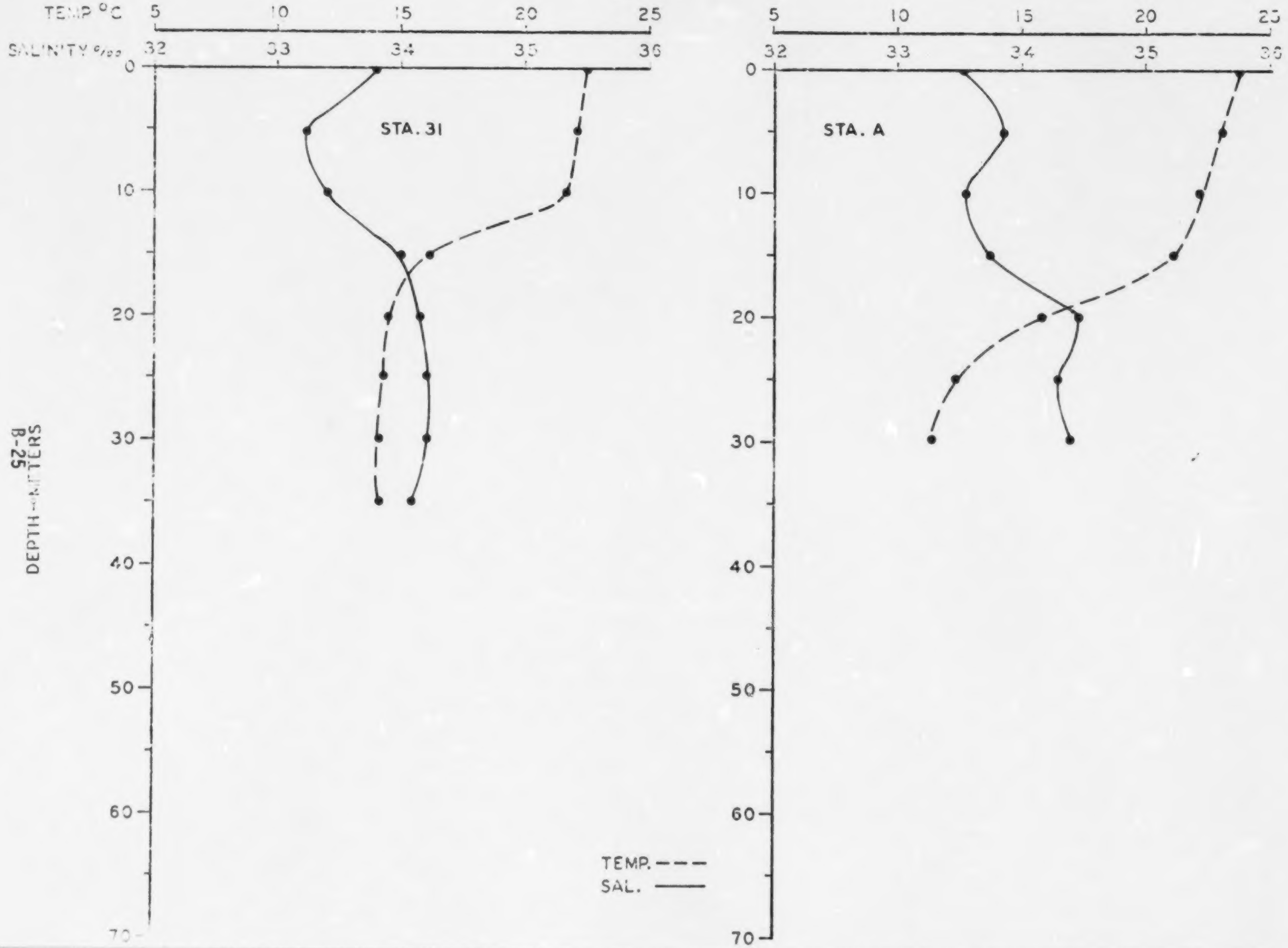
2 23

TEMPERATURE-SALINITY PROFILES
OPERATION DEEP SIX
FIGURE 2



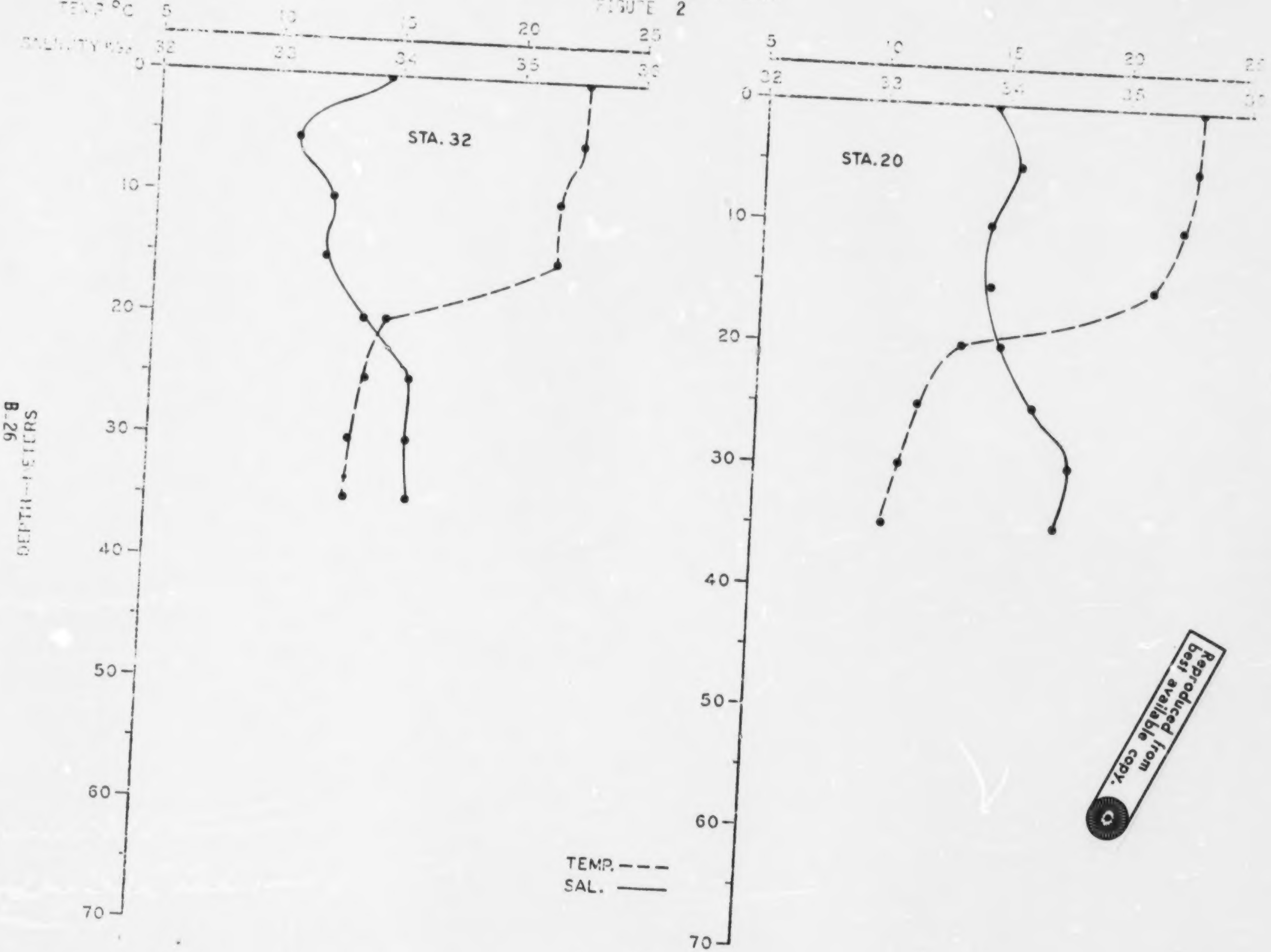
TEMPERATURE-SALINITY PROFILES
OPERATION DEEP SIX

FIGURE 2



TEMPERATURE-SALINITY PROFILES
OPERATION DEEP SIX

FIGURE 2



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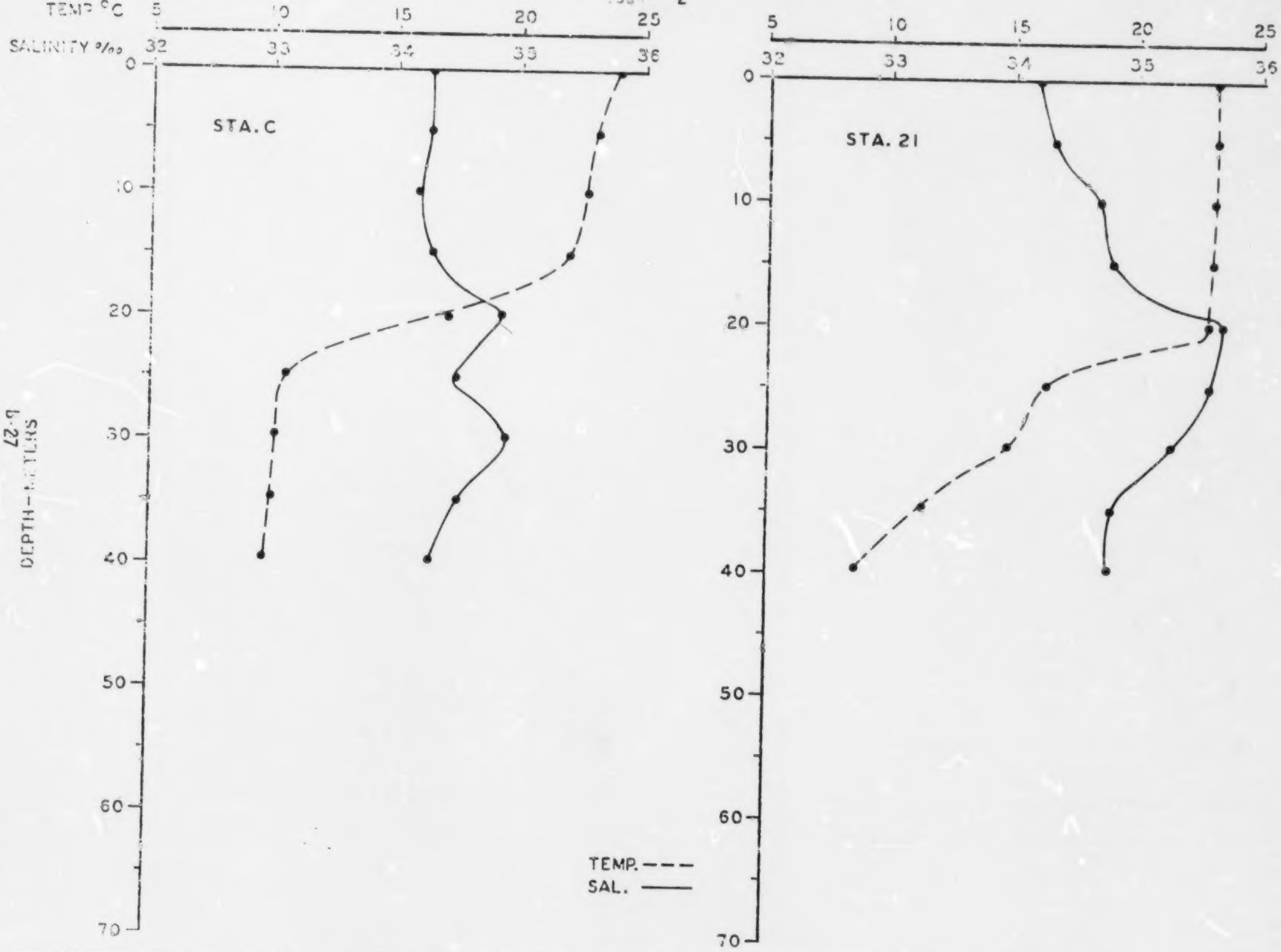
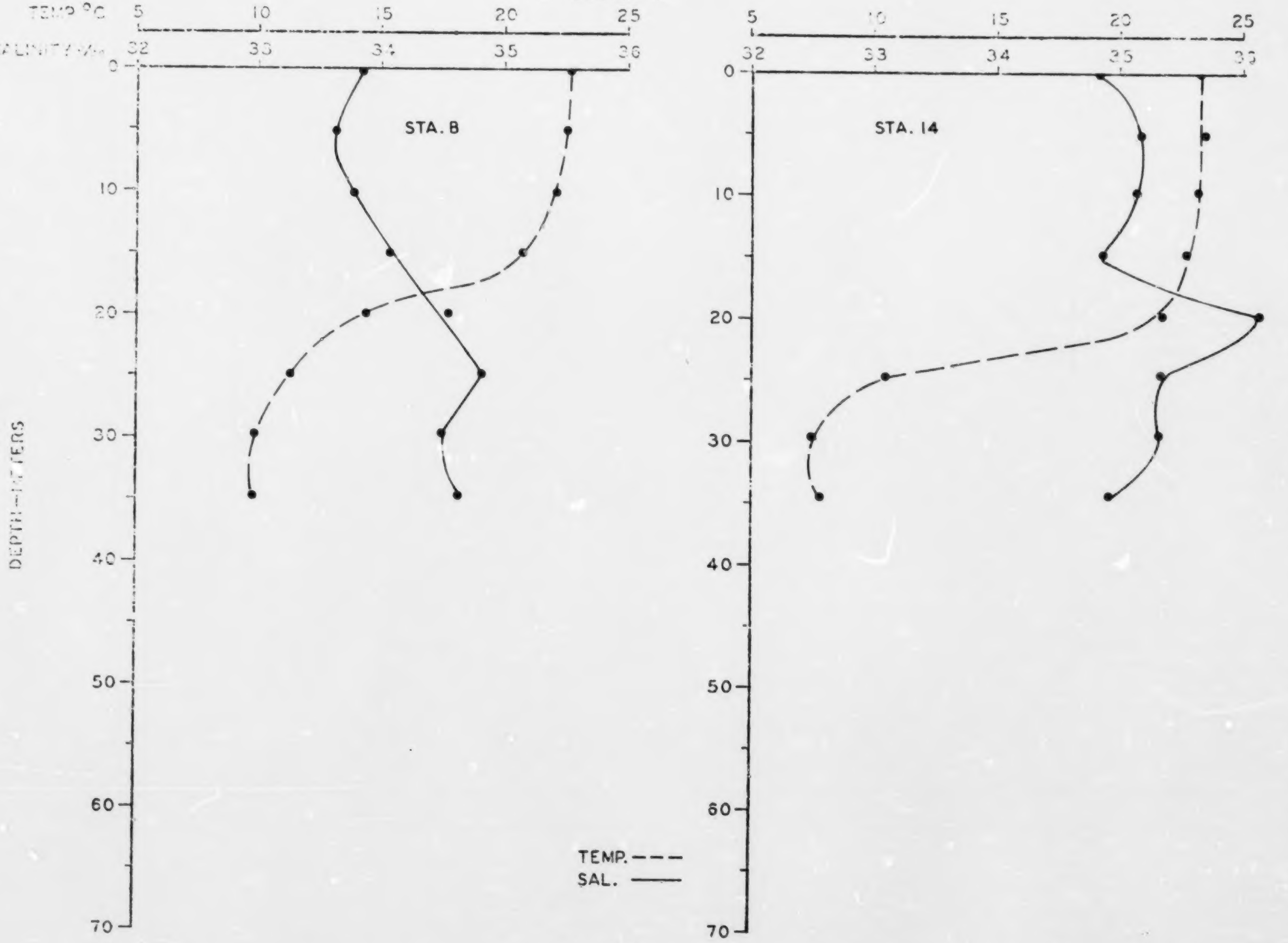
TEMPERATURE-SALINITY PROFILES
OPERATION DEEP SIX

FIGURE 2

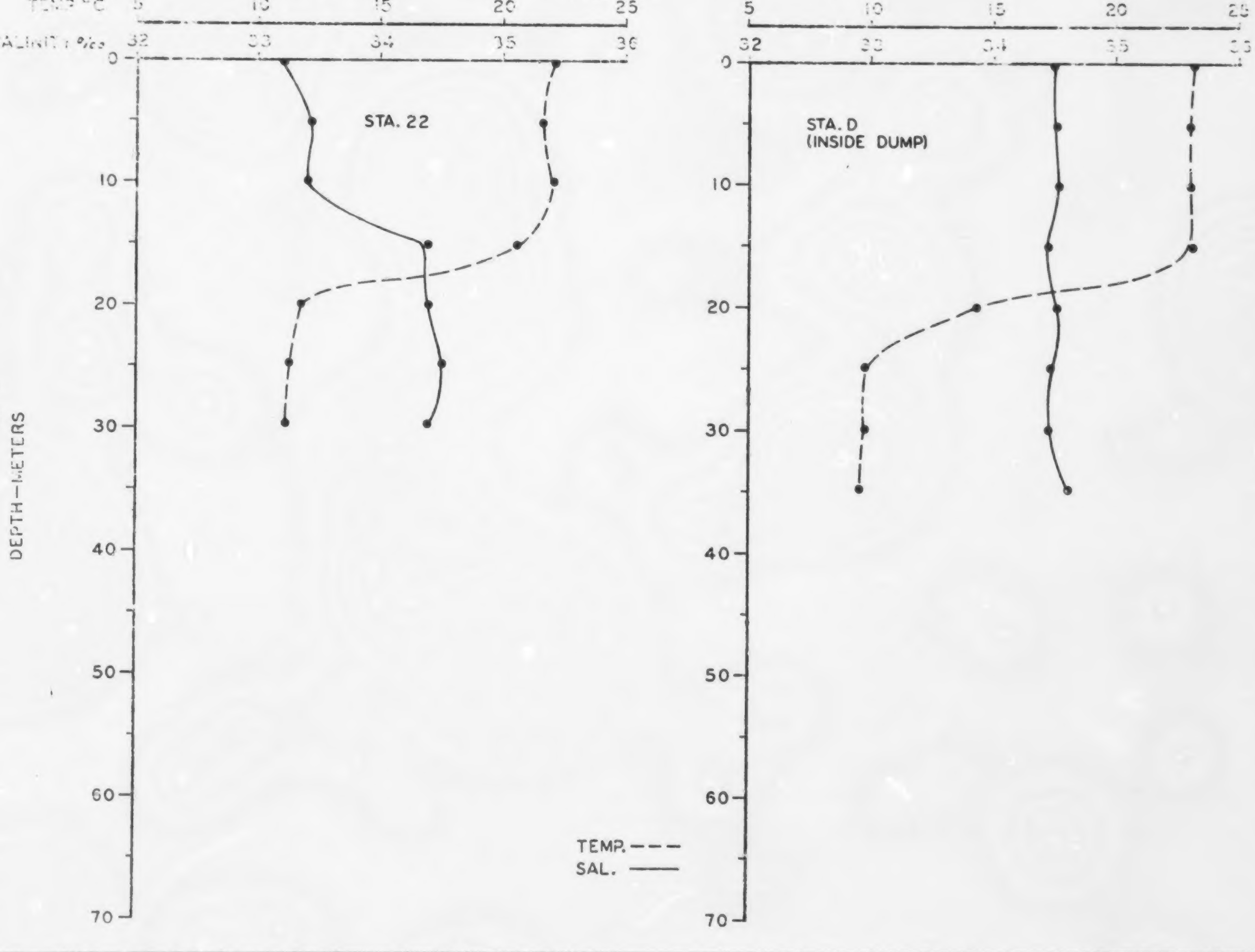


TEMPERATURE-SALINITY PROFILES
OPERATION DEEP SIX
FIGURE 2



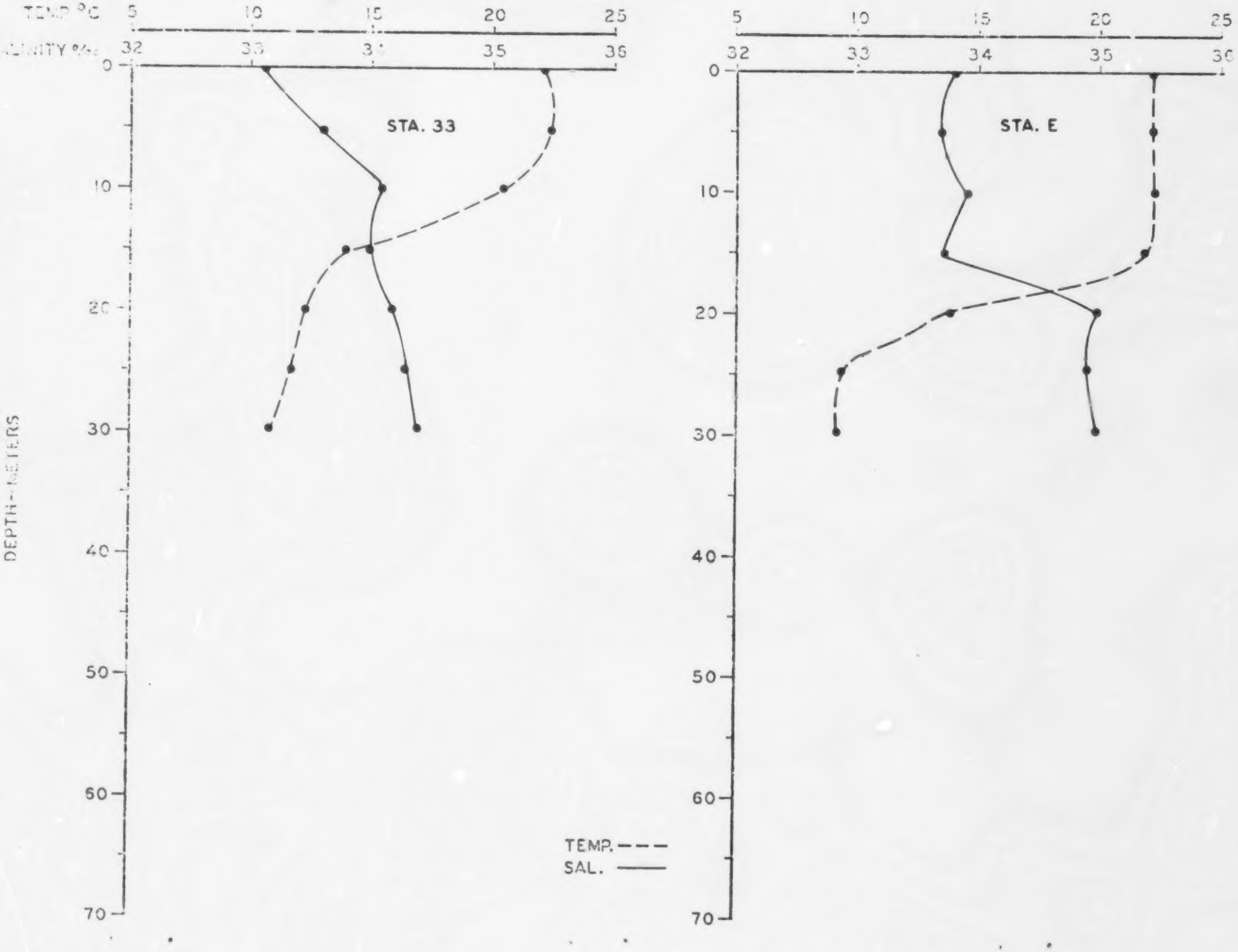
TEMPERATURE-SALINITY PROFILES
OPERATION DEEP SIX

FIGURE 2



TEMPERATURE-SALINITY PROFILES
OPERATION DEEP SIX

FIGURE 2



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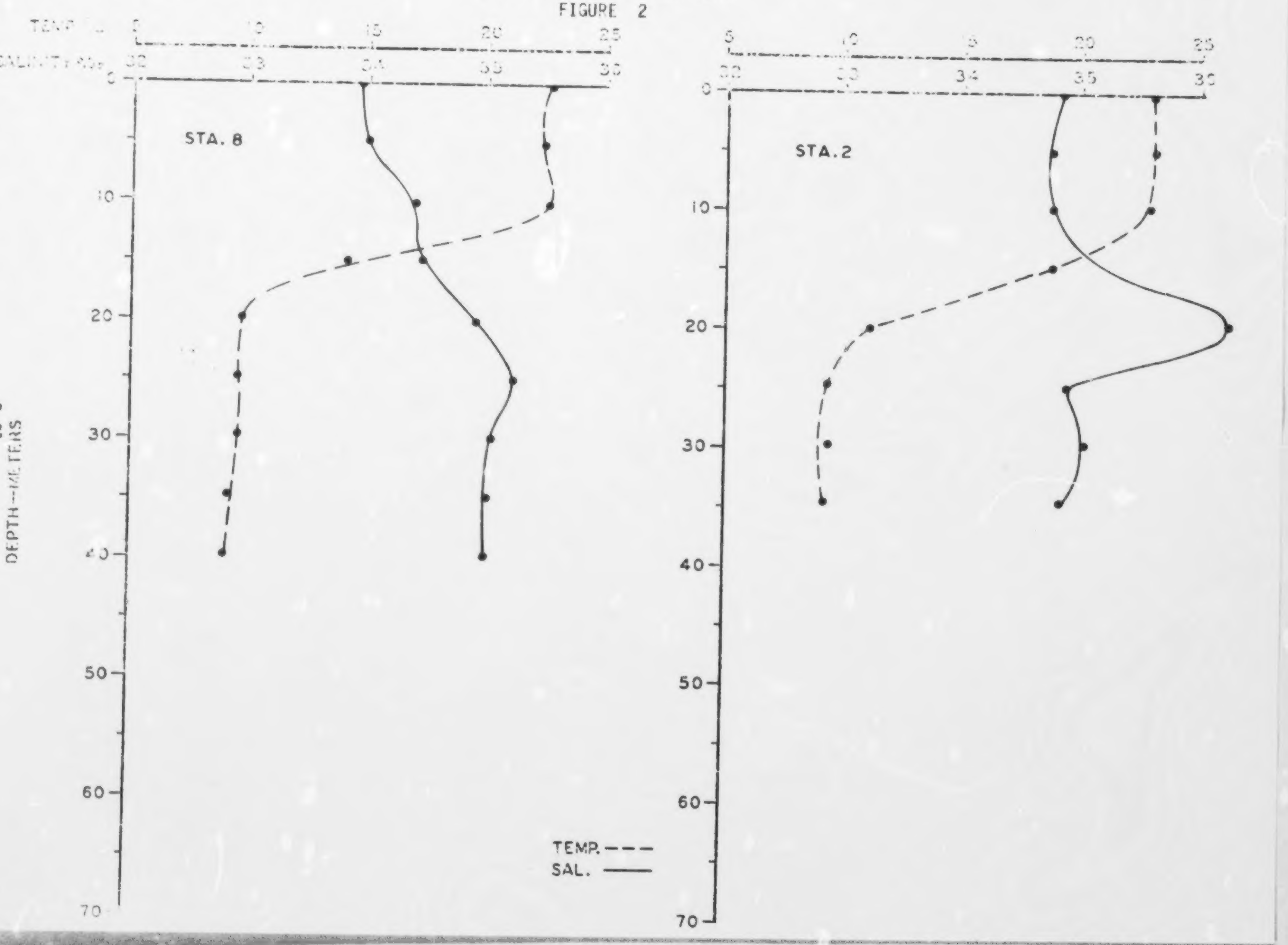
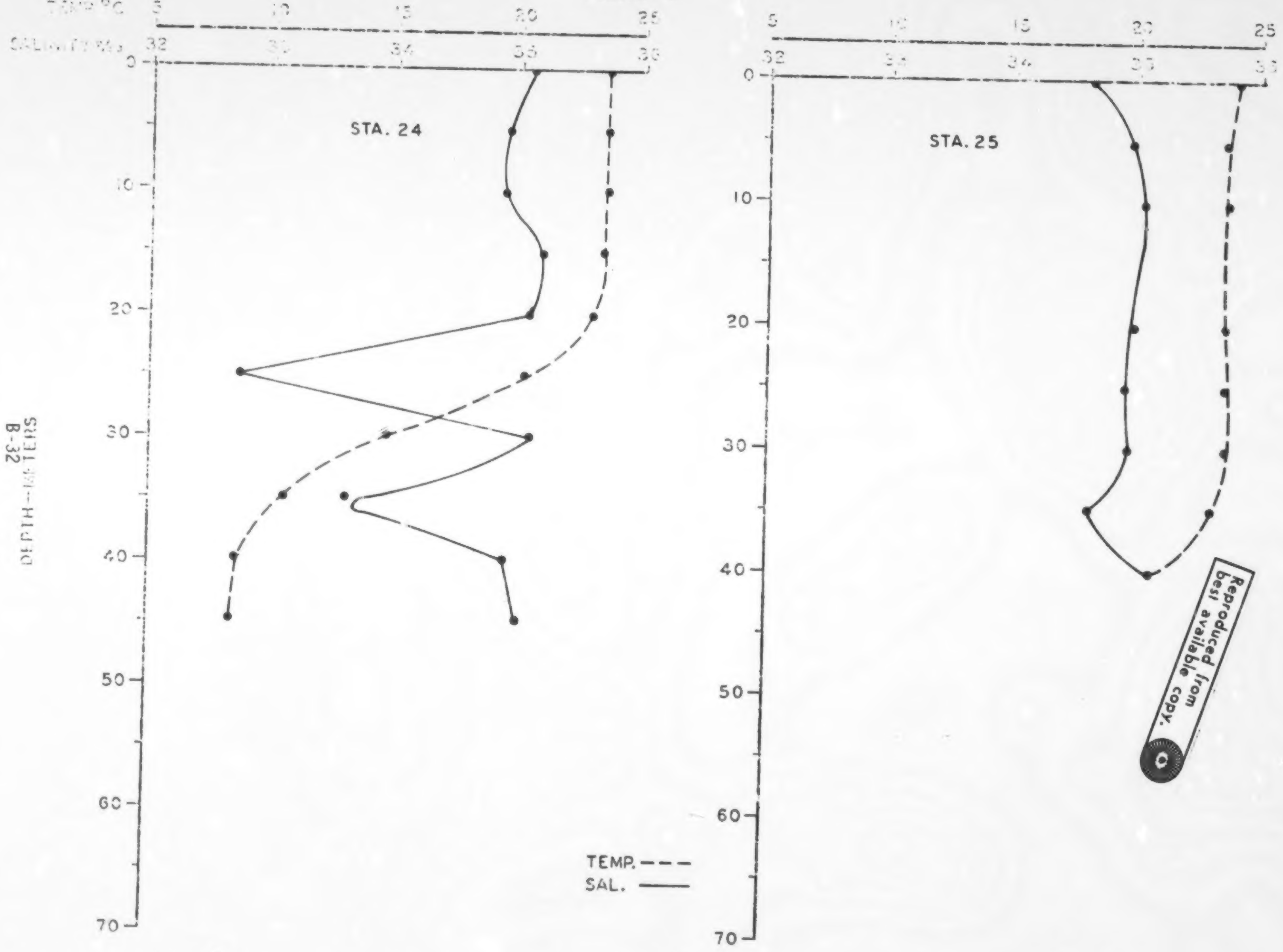
OPERATION DEEP SIX

FIGURE 2



TEMPERATURE-SALINITY PROFILES
OPERATION DEEP SIX
FIGURE 2



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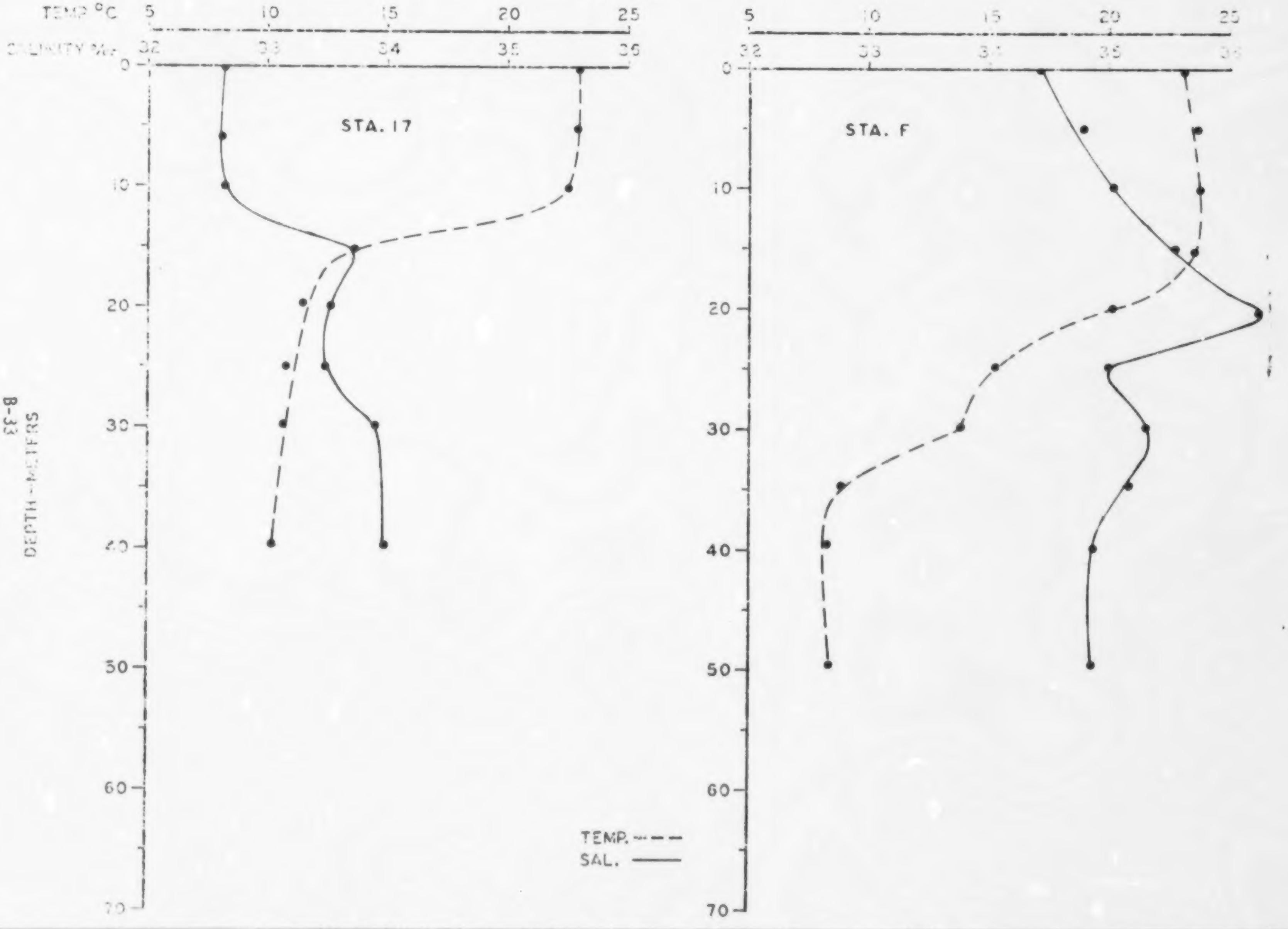
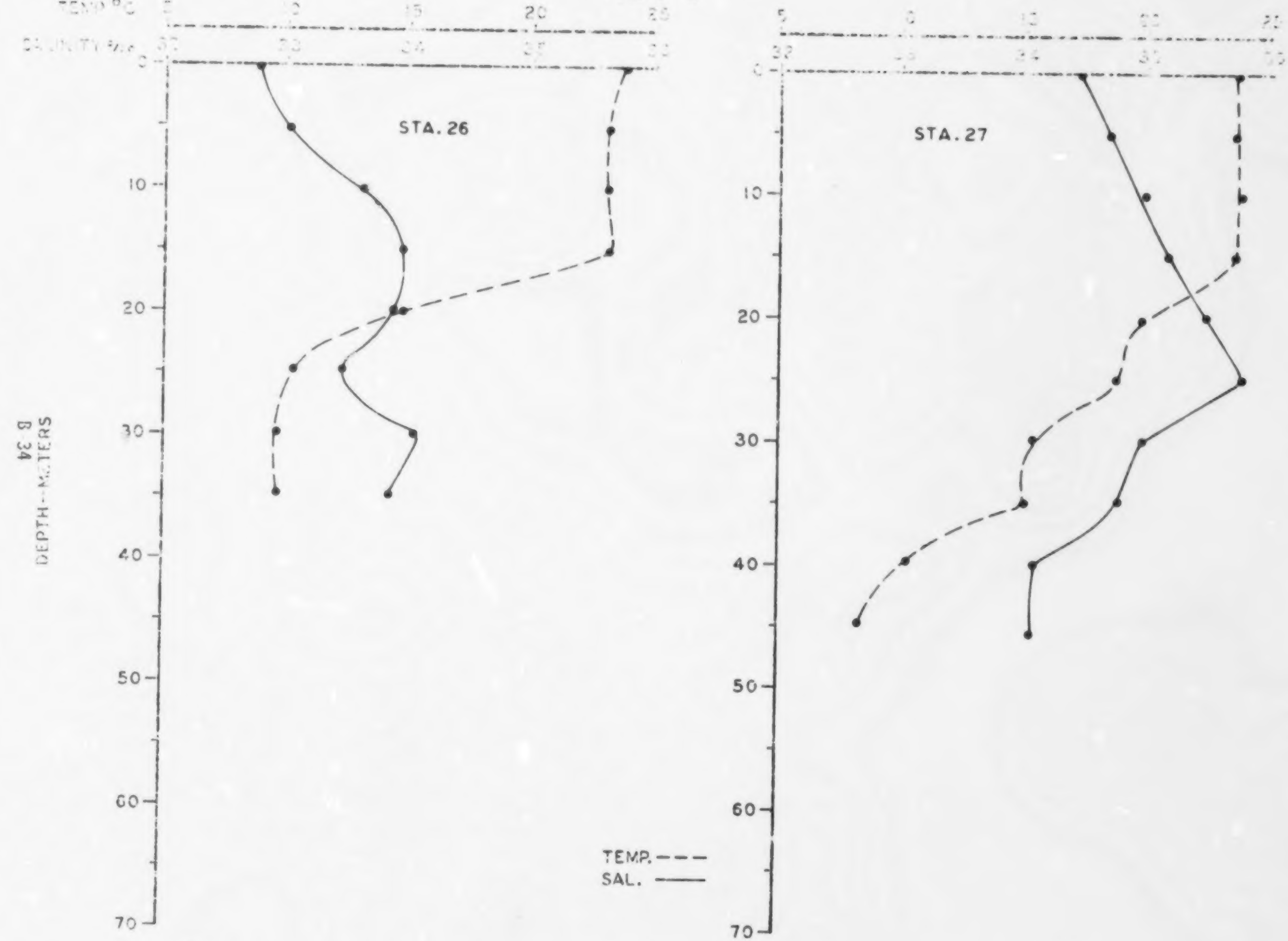
TEMPERATURE-SALINITY PROFILES
OPERATION DEEP SIX

FIGURE 2



TEMPERATURE-SALINITY PROFILES
OPERATION DEEP SIX

FIGURE 2



OPERATION "DEEP SIX"

BACTERIOLOGICAL RESULTS

Coliform determinations only were made on this cruise because of a malfunctioning incubator that was to be used for determination of fecal coliforms.

The bacteriological results again indicate no buildups of coliforms in the area (Table 3). Generally, the levels were below the detectable limits, less than 3 coliforms per 100 ml. And at Station 14, the bottom water indicated a 93 which may be anomalous due to the relatively primitive laboratory conditions aboard ship. Also, the sediments at Station E indicated 4 coliforms per 100 ml. The generally low counts of these organisms indicates no major buildup in bottom waters or sediments.

TABLE 3

OPERATION"DEEP SIX"
BACTERIOLOGICAL DATA

Station	Date	Time	Bottom Water Coliform MPN/100 ml	Sediment Coliform MPN/100 ml
2	8/13/74	1415	<3	<3
8	8/13/74	0850	<3	<3
9	8/15/74	0130	<3	<3
14	8/16/74	1810	93	<3
19	8/16/74	1055	<3	<3
26	8/14/74	1730	<3	<3
C	8/15/74	1800	<3	<3
E	8/13/74	0730	<3	4

OPERATION "DEEP SIX"

TOTAL ORGANIC CARBONS IN SEDIMENTS

The distribtuion of total organic carbon in sediments indicates higher values associated with the dump release zones and with Station F that also showed high concentrations of metals. Generally, there is a great deal of variation in the concentrations at stations that do not show accumulations of metals, which are used as tags for the ultimate fate of materials in this program.

These data indicate the possibility of increased total organic carbon in the areas of release of dump materials , both of the acid wastes and of the sewage sludge. This parameter should have more concentrated attention in future cruises.

TABLE 4

OPERATION "DEEP SIX"

Sediment Data
Total Carbon and Total Organic Carbon

Station	TC (mg/kg)	TOC (mg/kg)
2	300	140
8	450	270
8	510	330
9	160	060
14	300	150
17	240	100
18	220	090
19	550	360
20	570	410
21	370	170
22	710	500
24	210	070
25	290	090
25	340	180
26	350	180
27	180	040
28	240	070
29	470	250
31	340	200
32	460	310
33	170	050

OPERATION "DEEP SIX"

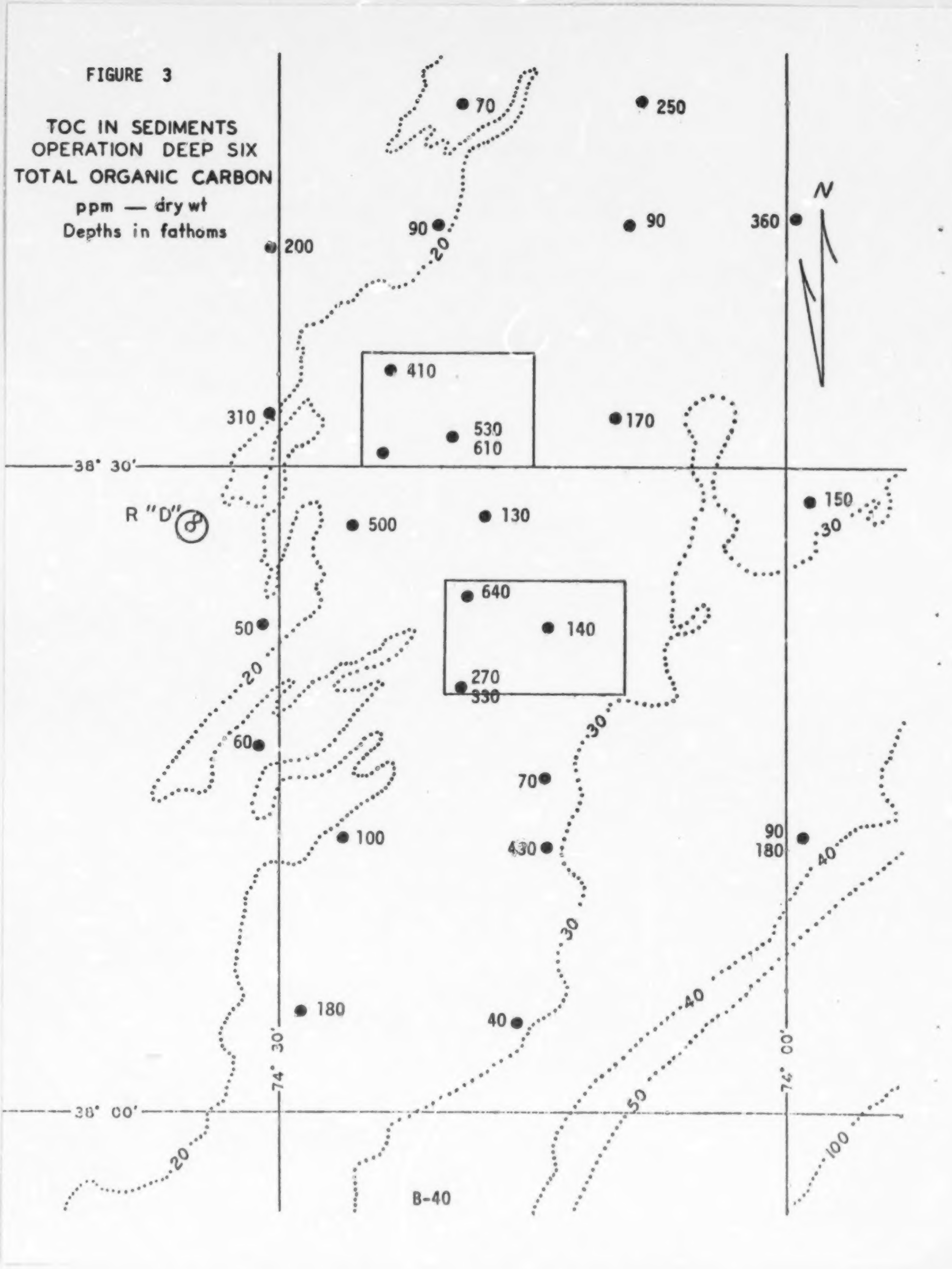
Sediment Data
Total Carbon and Total Organic Carbon

Station	TC (mg/kg)	TOC (mg/kg)
A	190	090
B	LA*	LA*
C	670	530
C	750	610
D	270	130
E	800	640
F	630	430

*Lab accident

FIGURE 3

TOC IN SEDIMENTS
OPERATION DEEP SIX
TOTAL ORGANIC CARBON
ppm — dry wt
Depths in fathoms



70
250
N
90
90
360
200
20
410
310
530
610
170
38° 30′
R "D"
500
130
150
30
640
140
50
20
270
330
30
60
70
100
430
90
180
40
30
180
40
40
74° 30′
74° 00′
38° 00′
50
20
100

OPERATION "DEEP SIX"

Metals in Sediments

P. G. Johnson

Sediment samples were taken using a Shipek sampler.

The sediment samples were transferred from whirl-paks to glass jars and well mixed. A portion (approximately 10 grams) was removed and spread to dry at room temperature for 48 hours. The samples were again mixed and pulverized to separate the sand grains and to expose surface areas. At this time any large rocks, pebbles, or shells (>5mm) were removed. The samples were allowed to air-dry at room temperature for an additional 48 hours.

A known weight (5.0000 gms) of dry sediment was put in a 125 ml glass-stoppered flask. Small amounts of deionized distilled water were used to aid in the transfer. The addition of 21.5 ml of concentrated nitric acid provided a digestion solution of 50-75 ml. This solution was heated at 48-50°C (1) for 4-6 hours in a shaking hot water bath. After digestion, the samples were cooled to room temperature and filtered through a .45 micron membrane filter and the volume adjusted to 100 ml. Blank solutions were run throughout the same digestion procedure (2, 3).

The filtered acid extracts were analyzed for Cd, Cr, Cu, Pb, Ni, Zn, Mn, and Fe using a Varian Techtron AA-6 atomic absorption spectrophotometer equipped with a standard pre-mix burner. Air-acetylene was used for all the metals. Standard operating parameters are shown in Table 5.

OPERATION "DEEP SIX"

Metals in Sediments

TABLE 5

Operating Conditions

	Cd	Cr	Cu	Pb	Zn	Ni	MN	Fe
Lamp Current (ma)	3	5	3	6	5	5	5	5
Fuel	A	A	A	A	A	A	A	A
Support	a	a	a	a	a	a	a	a
Flame Condition	0	R	0	0	0	0	0	0
Wavelength	228.8	357.9	324.7	217.0	213.9	232.0	279.5	386.0
Spectral Band Pass (nm)	.5	.2	.2	1.0	.2	.2	.2	.2
Working Range (mg/l)	.5-2	2-8	2-8	5-20	.4-1.6	3-12	1-4	50-200
Typical Sensitivity (mg/l)	.011	.055	.04	.11	.099	.066	.024	.90

A - acetylene, a - air, 0 - oxidizing, R - reducing

Mercury was analyzed using an automated flameless atomic absorption technique. All sediment results were xpressed as mg/kg dry weight.

The organisms were dissected for certain organs or digested whole. The digestion procedure used was the same as that used for the sediments except that a known wet weight was used and the results were expressed as mg/kg wet weight.

The calculations for the sediment and organisms are as follows:

$$\text{SEDIMENTS:}\quad \frac{\text{final answer (mg/l)}}{\frac{\text{5.0000 gms (dry)}}{\text{100 ml}} \times \frac{\text{1000 ml}}{\text{1 L}}} = \text{mg/gm} \times 1000 = \text{mg/kg dry}$$

$$\text{ORGANISMS:}\quad \frac{\text{final answer (mg/l)}}{\frac{\text{wet weight (gms)}}{\text{100 ml}} \times \frac{\text{1000 ml}}{\text{1 L}}} = \text{mg/gm} \times 1000 = \text{mg/kg wet}$$

Table 6
OPERATION "DEEP SIX"

Metals in Sediments mg/kg dry weight

Station	Cd	Cu	Cr	Fe	Hg	Mn	Ni	Pb	Zn
2	.12	.36	1.74	2312.38	.094	62.36	.78	2.69	4.04
2	.10	.36	1.74	2275.07	.368	50.86	.78	2.83	4.18
2	.12	.42	2.29	2523.85	.228	23.88	.87	2.56	4.53
2	.12	.36	2.29	2797.50	.188	31.84	1.04	3.37	5.07
2	.12	.30	2.29	2498.97	.208	94.64	.69	3.10	4.45
8	.19	.60	1.30	2150.68	LA*	34.49	.61	3.37	3.08
8	.10	<.06	.65	2001.41	.58	21.67	.17	2.02	1.84
8	.12	.30	.98	2038.73	3.48	31.40	.34	2.69	2.62
8	.08	.12	.43	1852.15	2.72	13.71	.17	2.15	2.24
8	.10	.21	.60	1920.56	5.04	28.74	.26	2.42	2.48
9	.06	.12	1.52	1678.00	3.12	24.32	.78	1.61	3.52
14	.10	.12	2.07	2511.41	4.64	45.78	.95	3.23	4.15
14	.12	.12	1.41	2436.77	.404	23.88	1.04	2.96	4.03
14	.10	.18	1.41	2474.09	.78	32.72	1.04	2.83	3.94
14	.06	.06	1.63	2312.38	.384	24.76	.95	2.56	3.70
14	.10	.18	1.96	2685.55	1.088	37.59	1.13	3.23	4.36

* Lab accident

OPERATION "DEEP SIX"

Metals in Sediments mg/kg dry weight (cont.)

Station	Cd	Cu	Cr	Fe	Hg	Mn	Ni	Pb	Zn
17	.08	.06	.76	2100.92	7.10	26.09	.43	1.88	2.79
18	.04	.36	1.19	2748.99	.208	24.76	.95	3.50	5.39
19	.08	.42	1.41	2574.84	1.106	18.57	1.04	4.31	5.00
20	.08	.91	2.50	3364.72	.340	25.42	2.44	4.38	8.60
21	.12	.30	1.52	1915.58	.152	32.72	1.22	3.10	3.09
22	.06	.06	2.61	2923.13	.118	18.57	1.22	3.23	4.67
24	.06	<.06	1.30	2102.17	.074	40.68	.78	2.96	2.42
25	.10	.06	1.41	1816.07	.368	70.76	1.13	3.37	2.70
26	.04	<.06	.76	1144.37	7.48	12.82	.69	2.02	1.71
27	.02	.12	.87	1654.37	.140	17.69	.95	1.75	2.31
28	.08	.18	1.19	3569.96	.128	30.95	.87	2.69	3.18
28	.08	.24	2.18	4453.12	.466	34.05	1.04	3.10	4.73
28	.04	.36	1.41	3731.66	.200	46.43	.95	2.96	3.97
28	.05	.48	1.52	4079.95	.219	46.88	1.04	3.98	4.12
28	.14	.60	1.09	3458.01	.114	30.51	1.13	2.56	4.17
29	.08	.12	1.74	2661.92	.132	23.88	1.04	2.29	3.34
31	.08	.54	2.29	3395.81	.136	38.47	1.91	4.45	8.41
32	.10	.12	1.30	2189.24	.088	20.34	.69	1.21	2.28

OPERATION "DEEP SIX"

Metals in Sediments mg/kg dry weight (cont.)

Station	Cd	Cu	Cr	Fe	Hg	Mn	Ni	Pb	Zn
33	.04	.36	1.30	2375.82	1.006	12.82	1.22	1.48	3.14
33	.08	.48	1.74	3370.93	.080	14.15	1.04	1.34	2.53
33	<.02	.36	1.09	2077.29	.180	13.71	.69	.67	2.10
33	.10	.48	1.41	2338.51	.034	21.67	1.30	1.48	3.24
33	.04	.48	1.63	2500.21	.068	18.57	1.57	1.61	4.43
A	.03	.84	1.24	1747.66	.092	15.70	.82	1.21	2.98
B	.08	.48	2.83	3258.98	.362	27.42	1.74	2.96	5.43
C	.08	.97	3.49	4428.24	.152	45.55	2.61	4.31	9.01
C	.06	1.03	3.59	4104.83	.094	28.74	2.53	4.45	9.79
C	.06	1.03	3.49	3955.56	.084	32.72	2.53	3.91	9.89
C	.06	1.09	3.70	3768.98	.068	28.30	2.35	4.04	9.50
C	.10	2.06	5.01	5112.38	.208	42.90	3.40	5.93	12.54
D	.02	.36	1.74	1505.10	.118	22.11	.52	1.07	2.09
E	.14	2.42	3.05	3072.40	.242	20.78	2.09	7.55	10.38
E	.08	1.94	3.59	2923.13	.078	18.57	1.91	6.47	9.79
E	.11	1.15	1.52	1362.05	.045	15.70	1.04	3.70	4.05
E	.10	2.36	4.14	3097.28	.014	22.11	2.18	7.68	1.03

OPERATION "DEEP SIX"

Metals in Sediments mg/kg dry weight (cont.)

Station	Cd	Cu	Cr	Fe	Hg	Mn	Ni	Pb	Zn
E	.21	2.79	4.58	2985.33	.188	17.24	2.00	8.76	11.32
F	.10	1.15	3.81	4677.02	.040	59.70	2.61	5.12	8.86
F	.08	1.27	4.14	4838.72	.248	38.92	2.61	4.18	9.15
F	.14	1.51	4.03	4900.92	.164	37.15	2.87	4.85	10.04
F	.12	1.45	3.92	5124.82	.168	43.34	2.96	4.85	10.33
F	.14	1.33	3.59	4602.38	1.068	61.91	2.96	4.99	9.95

OPERATION "DEEP SIX"

DISTRIBUTION OF METALS IN SEDIMENTS

The distribution of metals in sediments was different than previous cruises. For the analysis of the distribution of these metals, the higher concentrations were contoured visually. Then the distribution hypothesis tested statistically showed that the contoured areas were statistically signifiant from the remaining area. The nonparametric Mann-Whitney U-test was used for these purposes and the distributions as shown are statistically discrete. It would appear again, as noted in Operation "Ides", that the material from each of the release zones are settling separately to the bottom. The coincidence of the contours of many of the metals make this hypothesis very tenable.

During the summer season, with stratification well developed, the residual materials reaching the bottom would appear to be northwest of the acid release site and in the sewage sludge site and at one station, Station F, to the south of the sewage sludge site.

The incidence of single stations showing relative high values, compared to surrounding stations, may indicate that (1) discrete patches of released materials are being moved about the bottomeither as large aggregations or as single dumps, or (2) the releases may not be made accurately within the dumpsites.

The different distributions of metals in sediments found on different cruises indicate the metals released through ocean dumping activities are probably mobile along the sediment-water interface and not remaining in any discrete area.

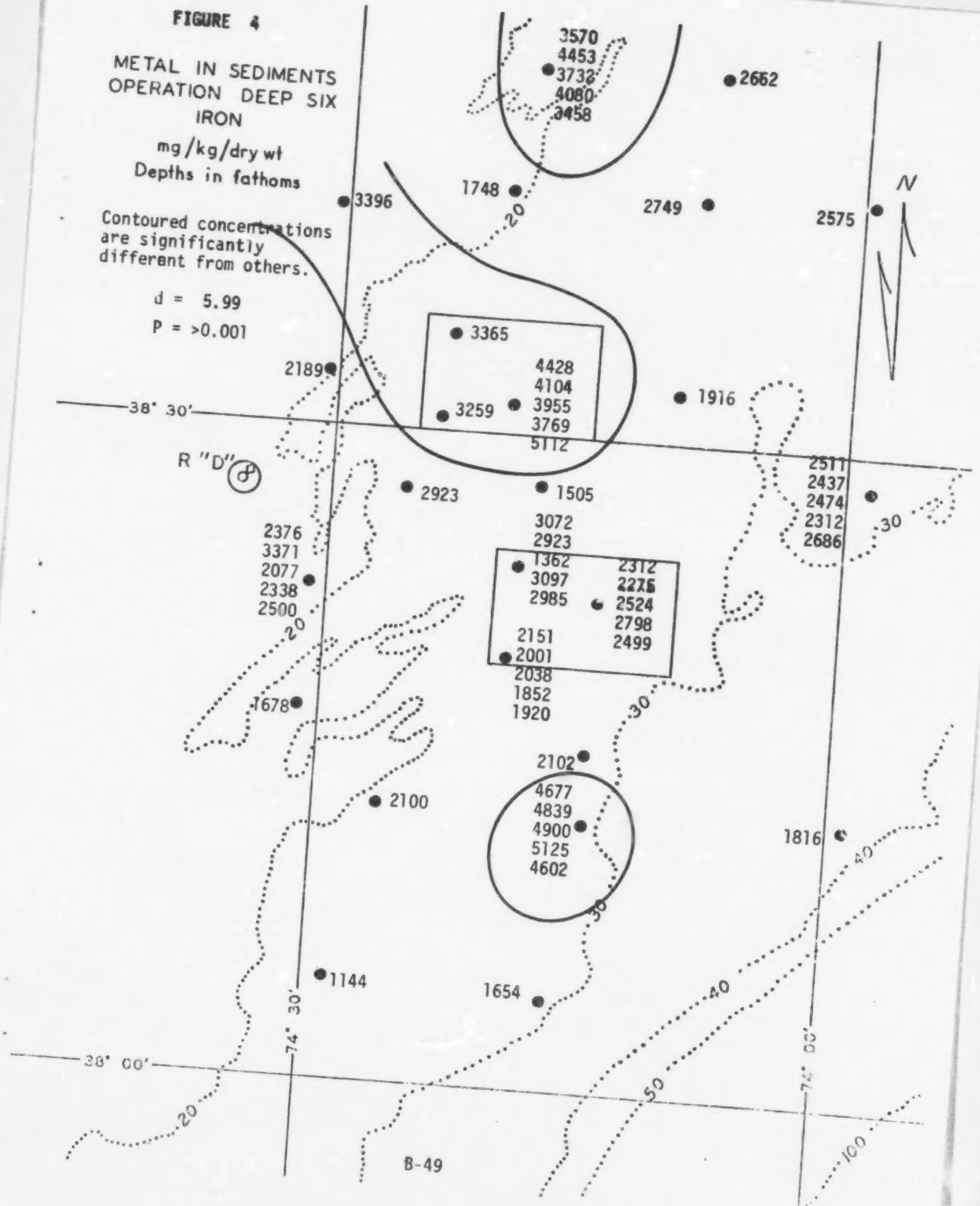


FIGURE 4

METAL IN SEDIMENTS
OPERATION DEEP SIX
IRON

mg/kg/dry wt
Depths in fathoms

Contoured concentrations are significantly different from others.

d = 5.99
P = >0.001

3570
4453
3732
4080
3458
2652
1748
20
3396
2749
2575
N
3365
2189
4428
4104
3955
3769
5112
3259
1916
38° 30′
R "D" 8
2511
2437
2474
2312
2686
30
2923
1505
3072
2923
1362
3097
2985
2312
2275
2524
2798
2499
2376
3371
2077
2338
2500
20
2151
2001
2038
1852
1920
1678
30
2102
2100
4677
4839
4900
5125
4602
1816
40
30
1144
1654
74° 30′
40
38° 00′
74° 00′
50
20
100

FIGURE 5

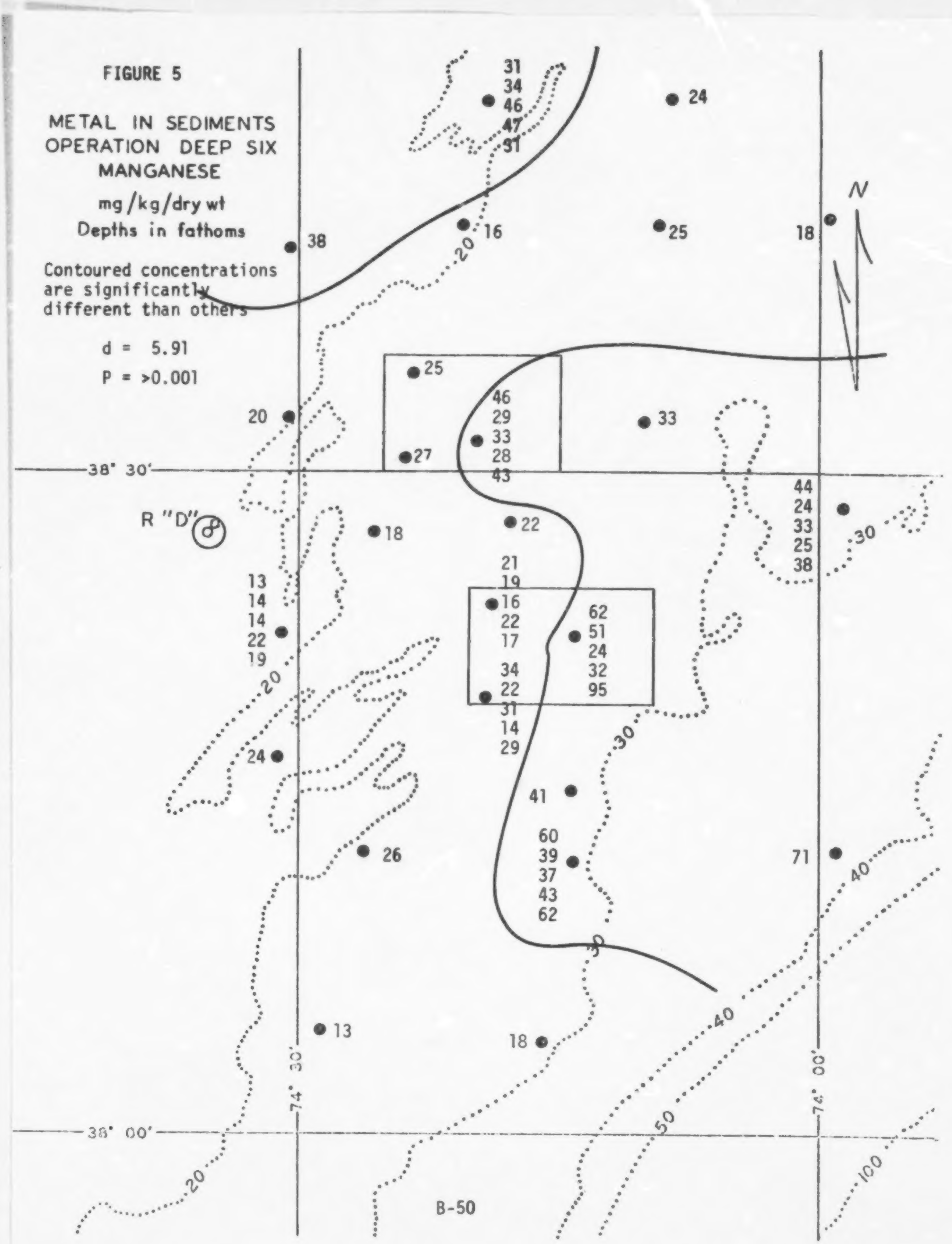
METAL IN SEDIMENTS
OPERATION DEEP SIX
MANGANESE

mg/kg/dry wt
Depths in fathoms

Contoured concentrations are significantly different than others

d = 5.91

P = >0.001



31
34
46
47
51
24
38
16
20
25
18
N
25
46
29
33
28
43
20
27
33
38° 30'
R "D"
18
22
44
24
33
25
38
30
21
19
16
22
17
34
22
31
14
29
62
51
24
32
95
13
14
14
22
19
20
24
30
41
26
60
39
37
43
62
71
40
30
13
18
40
74° 30'
74° 00'
38° 00'
50
20
100

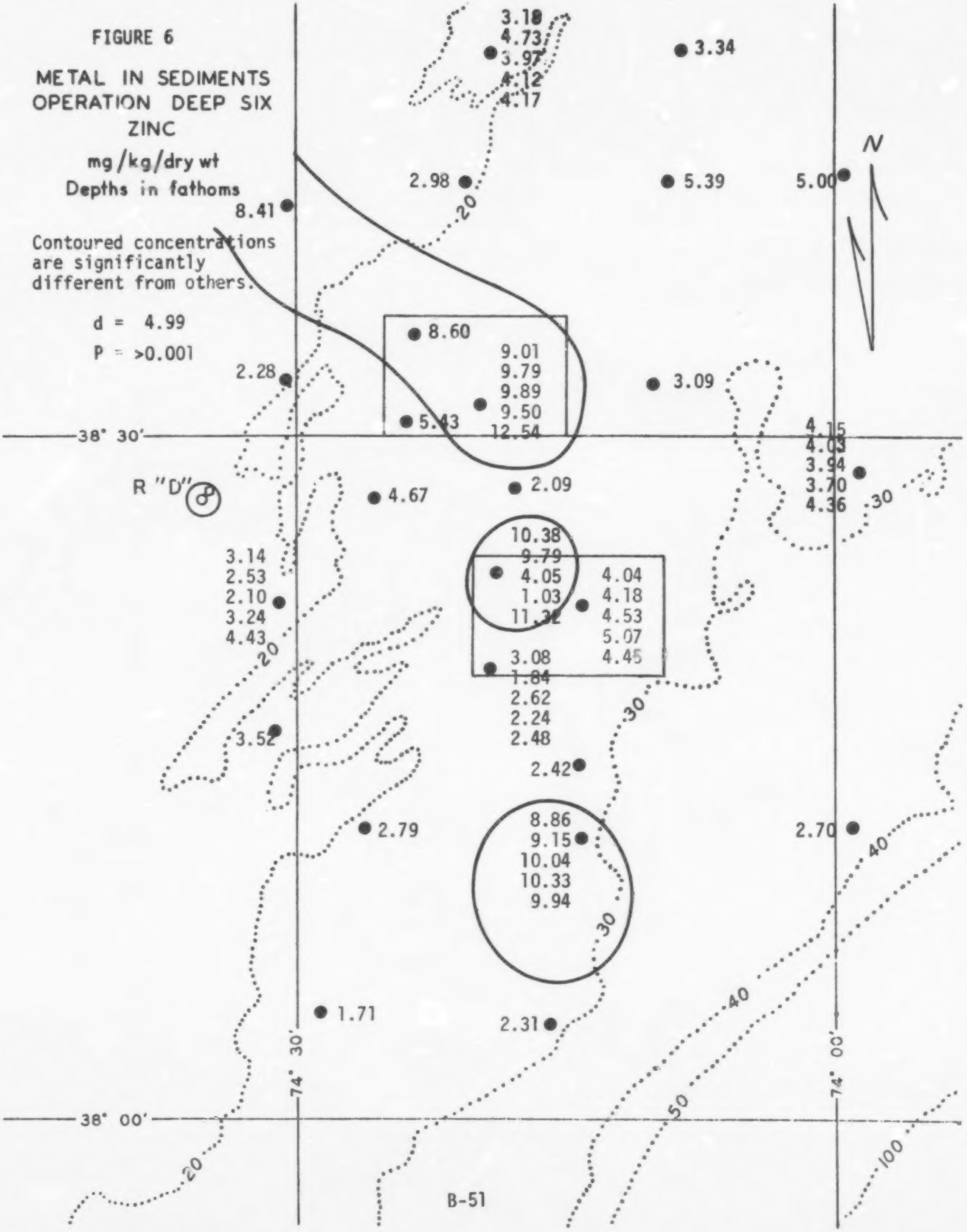


FIGURE 6

METAL IN SEDIMENTS
OPERATION DEEP SIX
ZINC

mg/kg/dry wt
Depths in fathoms

Contoured concentrations are significantly different from others.

d = 4.99
P = >0.001

3.18
4.73
3.97
4.12
4.17
3.34
N
2.98
20
5.39
5.00
8.41
8.60
9.01
9.79
9.89
9.50
12.54
2.28
3.09
5.43
38° 30'
4.15
4.03
3.94
3.70
4.36
30
R "D"
4.67
2.09
10.38
9.79
4.05
1.03
11.32
4.04
4.18
4.53
5.07
4.45
3.14
2.53
2.10
3.24
4.43
20
3.08
1.84
2.62
2.24
2.48
30
3.52
2.42
8.86
9.15
10.04
10.33
9.94
2.79
2.70
40
30
1.71
2.31
40
74° 30'
74° 00'
38° 00'
50
20
100

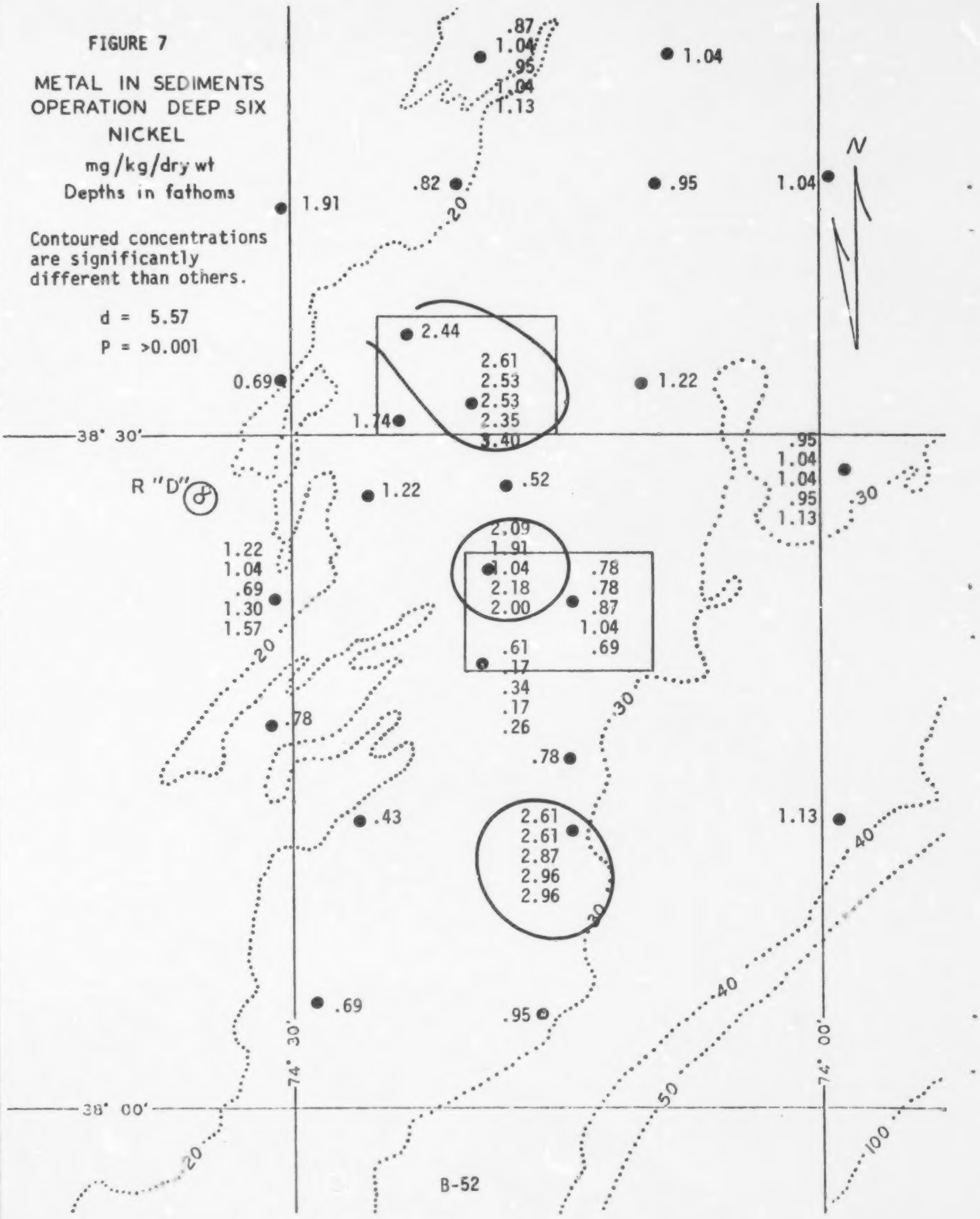


FIGURE 7

METAL IN SEDIMENTS
OPERATION DEEP SIX
NICKEL
mg/kg/dry wt
Depths in fathoms

Contoured concentrations are significantly different than others.

d = 5.57
P = >0.001

.87
1.04
.95
1.04
1.13
1.04
N
.82
.95
1.04
1.91
20
2.44
2.61
2.53
2.53
2.35
3.40
0.69
1.74
1.22
38° 30'
.95
1.04
1.04
.95
1.13
30
R "D"
1.22
.52
2.09
1.91
1.04
2.18
2.00
.78
.78
.87
1.04
.69
1.22
1.04
.69
1.30
1.57
20
.61
.17
.34
.17
.26
30
.78
.78
.43
2.61
2.61
2.87
2.96
2.96
30
1.13
40
40
.69
.95
74° 30'
74° 00'
38° 00'
50
100
20

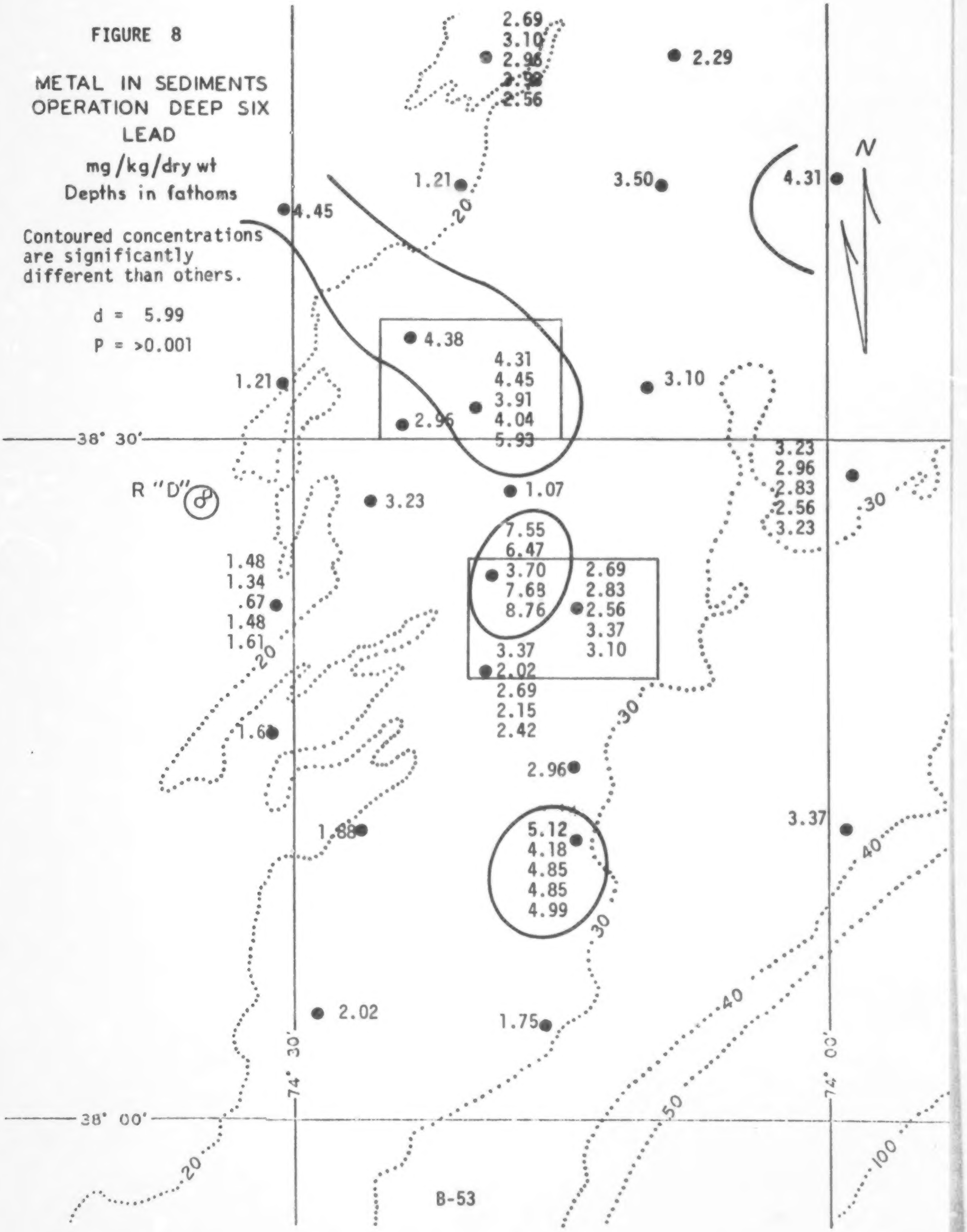


FIGURE 8

METAL IN SEDIMENTS
OPERATION DEEP SIX
LEAD
mg/kg/dry wt
Depths in fathoms

Contoured concentrations are significantly different than others.

d = 5.99
P = >0.001

2.69
3.10
2.96
2.98
2.56
2.29
1.21
20
3.50
4.31
N
4.45
4.38
4.31
4.45
3.91
4.04
5.93
1.21
2.96
3.10
38° 30'
3.23
2.96
2.83
2.56
3.23
30
R "D"
3.23
1.07
7.55
6.47
3.70
7.68
8.76
2.69
2.83
2.56
3.37
3.10
1.48
1.34
.67
1.48
1.61
20
3.37
2.02
2.69
2.15
2.42
30
1.6
2.96
3.37
40
1.88
5.12
4.18
4.85
4.85
4.99
30
40
2.02
1.75
74° 30'
74° 00'
50
38° 00'
20
100

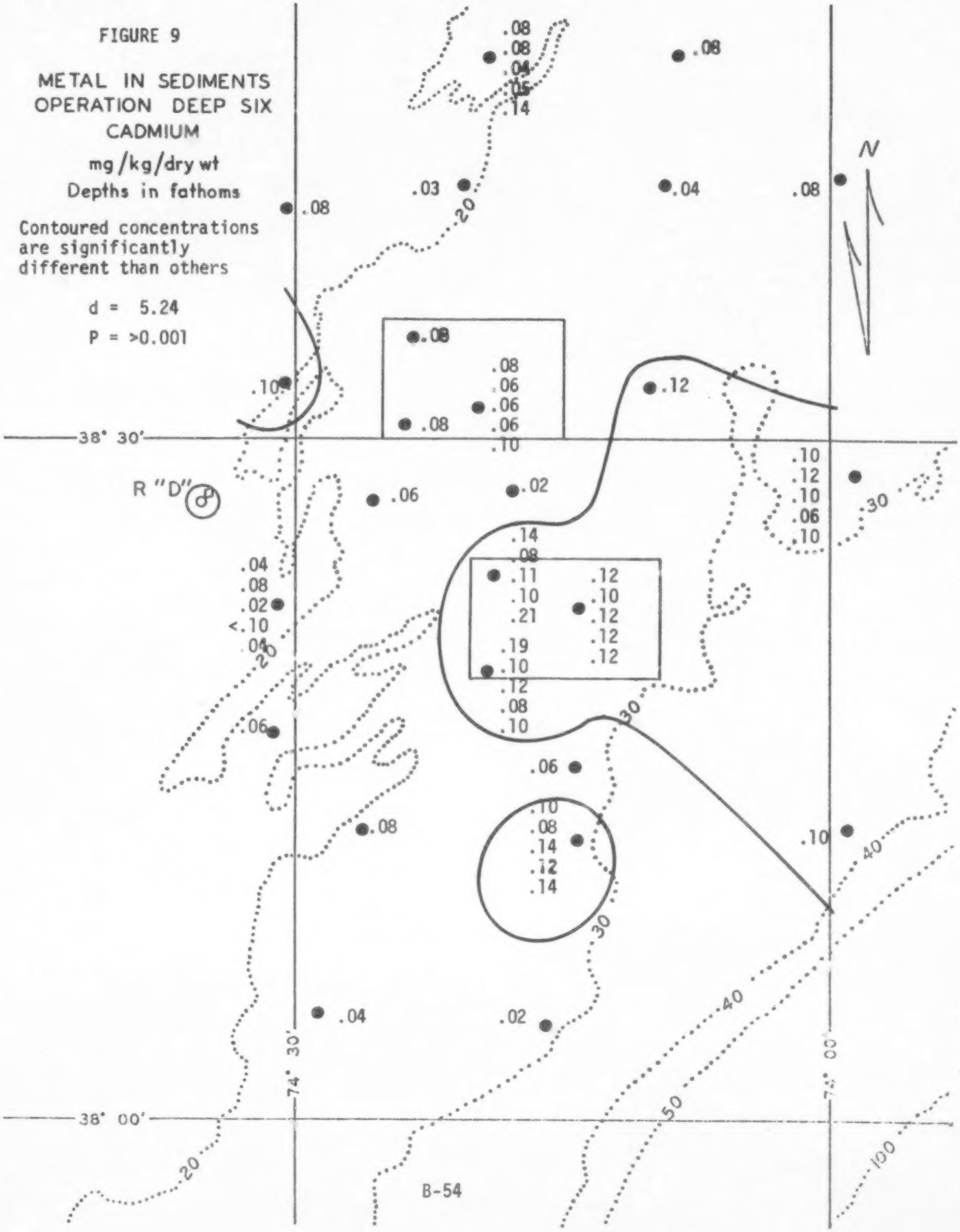
FIGURE 9

METAL IN SEDIMENTS
OPERATION DEEP SIX
CADMIUM

mg/kg/dry wt
Depths in fathoms

Contoured concentrations
are significantly
different than others

d = 5.24
P = >0.001



.08
.08
.04
.05
.14
.08
N
.03
20
.04
.08
.08
.08
.08
.06
.06
.06
.10
.10
.12
38° 30′
.10
.12
.10
.06
.10
30
R "D"
.06
.02
.14
.08
.11
.10
.21
.19
.10
.12
.08
.10
.12
.10
.12
.12
.12
.04
.08
.02
<.10
.04
20
.06
30
.06
.08
.10
.08
.14
.12
.14
.10
40
30
.04
.02
40
74° 30′
74° 00′
50
38° 00′
20
100

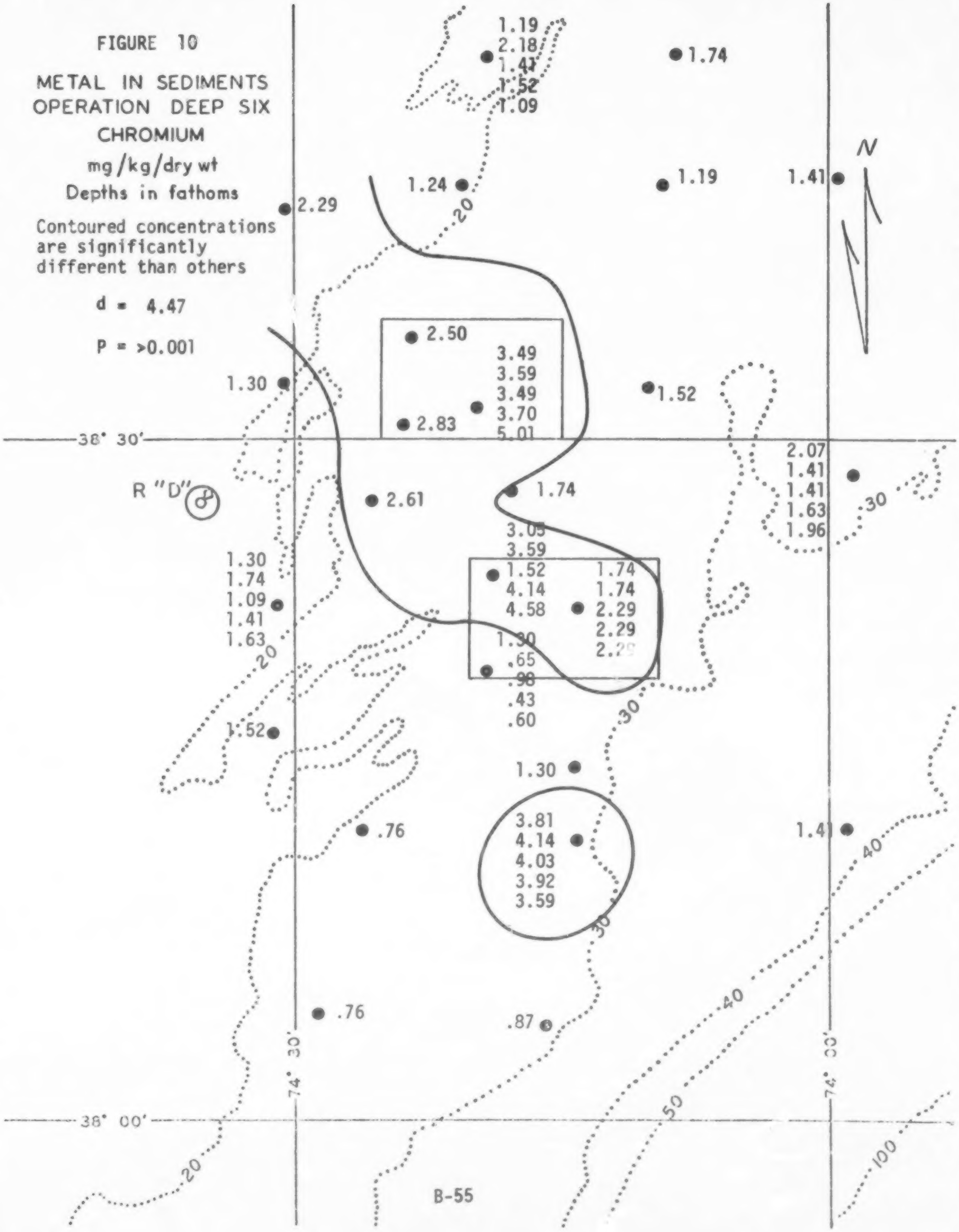


FIGURE 10

METAL IN SEDIMENTS
OPERATION DEEP SIX
CHROMIUM

mg/kg/dry wt
Depths in fathoms

Contoured concentrations are significantly different than others

d = 4.47

P = >0.001

1.19
2.18
1.41
1.52
1.09
1.74
1.24
20
1.19
1.41
N
2.29
2.50
3.49
3.59
3.49
3.70
5.01
1.30
1.52
2.83
38° 30'
2.07
1.41
1.41
1.63
1.96
30
R "D"
1.74
2.61
3.05
3.59
1.52
4.14
4.58
1.74
1.74
2.29
2.29
2.29
1.30
1.74
1.09
1.41
1.63
20
1.30
.65
.98
.43
.60
30
1.52
1.30
3.81
4.14
4.03
3.92
3.59
.76
1.41
40
30
.76
.87
40
74° 30'
74° 00'
50
38° 00'
20
100

FIGURE 11

METAL IN SEDIMENTS
OPERATION DEEP SIX
COPPER

mg/kg/dry wt
Depths in fathoms

Contoured concentrations are significantly different than others

d = 5.71
P = >0.01

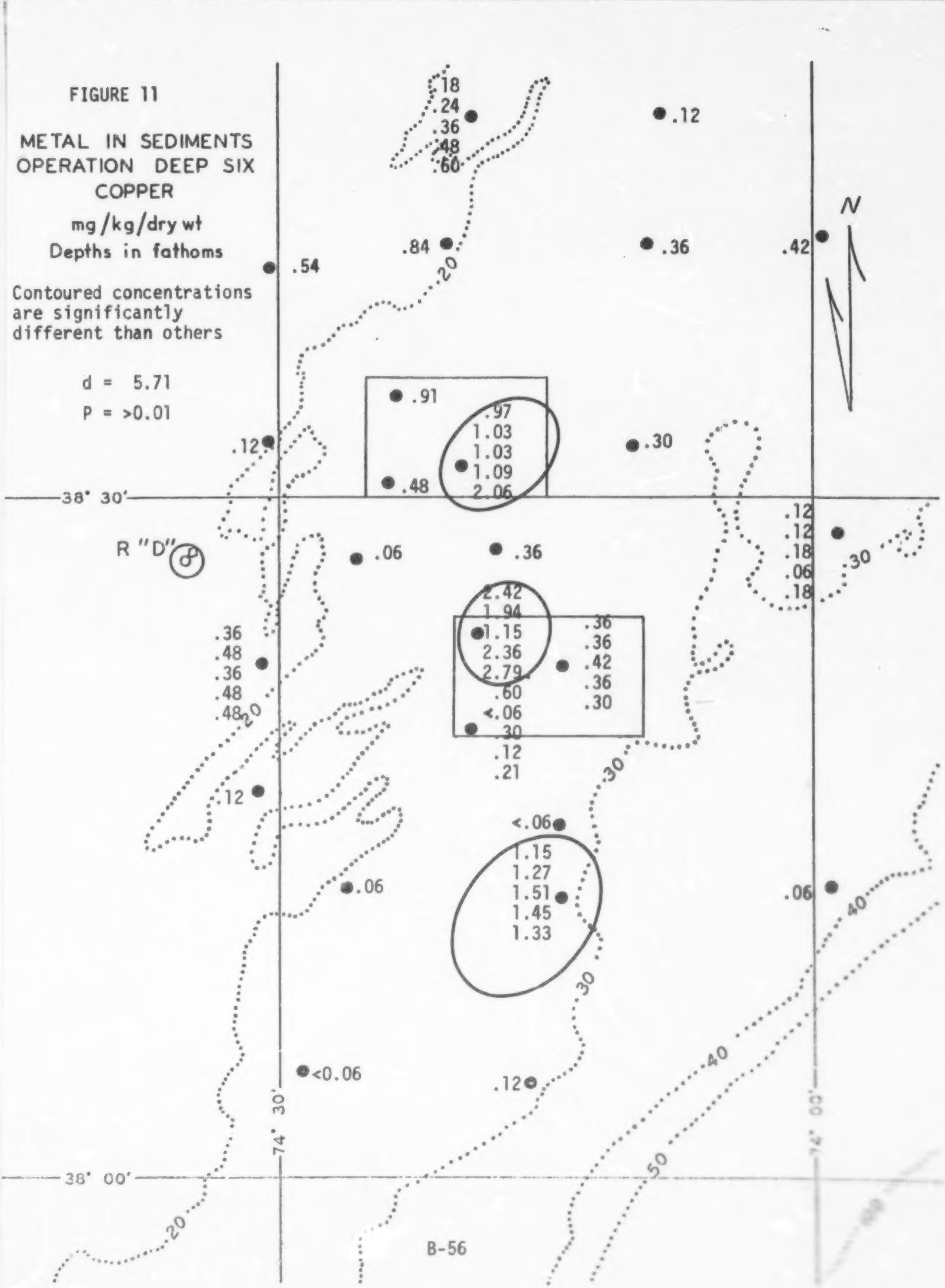
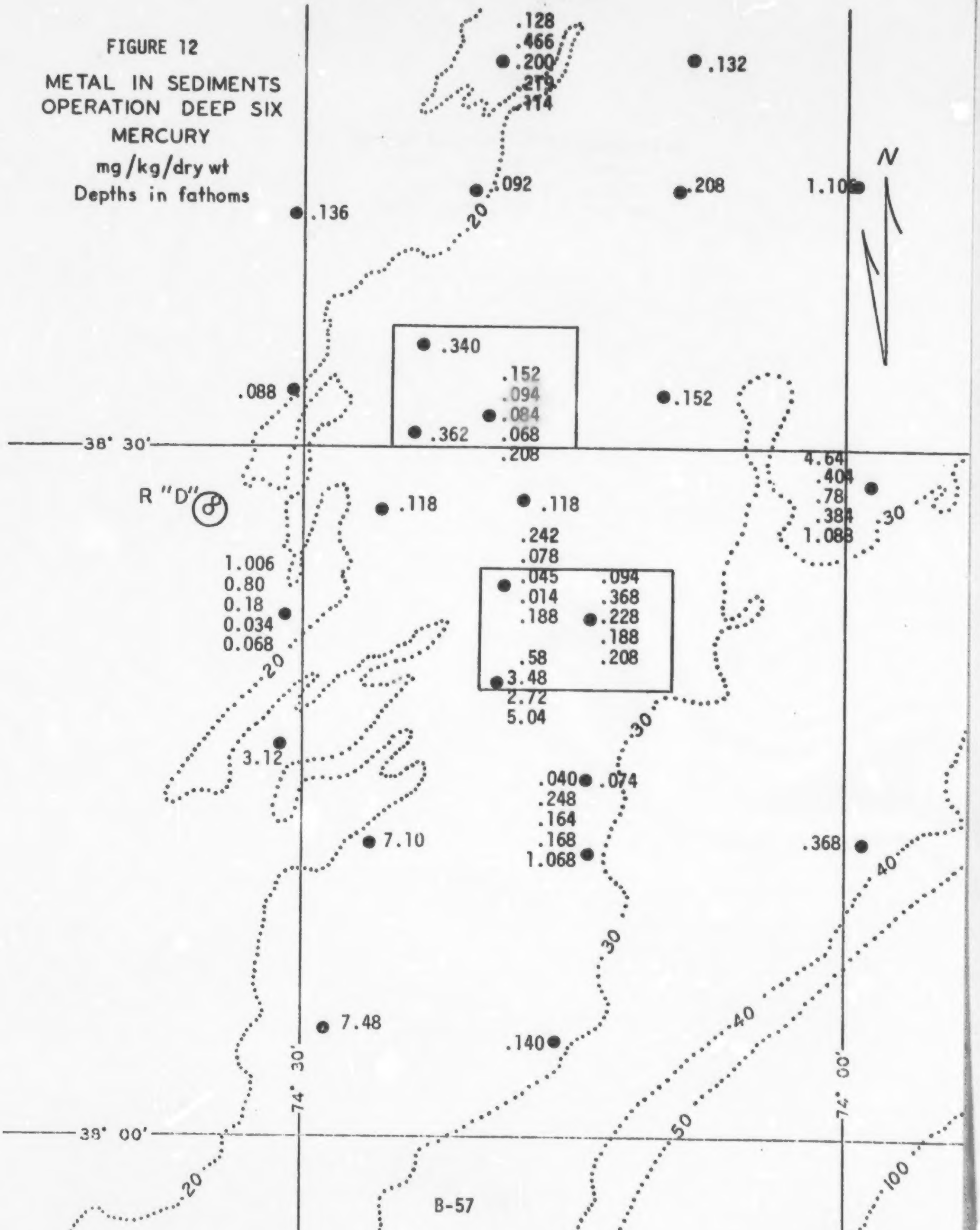

.18
.24
.36
.48
.60
.12
N
.84
20
.36
.42
.54
.91
.97
1.03
1.03
1.09
2.06
.12
.30
.48
38° 30'
.12
.12
.18
.06
.18
30
R "D"
.06
.36
2.42
1.94
1.15
2.36
2.79
.60
<.06
.30
.12
.21
.36
.36
.42
.36
.30
.36
.48
.36
.48
.48
20
30
.12
<.06
1.15
1.27
1.51
1.45
1.33
.06
.06
40
30
40
<0.06
.12
74° 30'
74° 00'
50
38° 00'
20
400

FIGURE 12

METAL IN SEDIMENTS
OPERATION DEEP SIX
MERCURY
mg/kg/dry wt
Depths in fathoms


.128
.466
.200
.219
.114
.132
N
.092
20
.208
1.106
.136
.340
.152
.094
.084
.068
.208
.088
.152
.362
38° 30'
4.64
.404
.78
.384
1.088
30
R "D"
.118
.118
.242
.078
.045
.014
.188
.094
.368
.228
.188
.208
1.006
0.80
0.18
0.034
0.068
20
.58
3.48
2.72
5.04
30
3.12
.040
.074
.248
.164
.168
1.068
7.10
.368
40
30
7.48
.140
40
74° 30'
74° 00'
50
38° 00'
20
100

Environmental Protection Agency
Annapolis Field Office
Annapolis Science Center
Annapolis, Maryland 21401

OPERATION "DEEP SIX"

Cruise Plan

August 12-17, 1974

Cruise Plan - Operation "Deep Six", USCGC Alert, August 12-17, 1974

Observations of the environmental effects of ocean disposal practices have been made by EPA since the spring of 1973 on two dumpsites off the coast of Delaware and Maryland. The cruise plans were designed primarily to look at the long-term effects of the dumping practices on the continental shelf environment. The findings to date, although all the data are not completely analyzed, indicate that certain metals from the disposed materials are settling to the bottom in a fairly wide area from the release zones. Quite a bit of variability in replicate sampling of this material has been noted. The metals, which are potentially biocidal materials as well as indicators of the fate of these pollutants, appear to settle geographically in response to hydrographic regimes, especially discontinuities such as the pycnocline. The bottom materials are fairly coarse sands. These observations might indicate that the metals floc or precipitate out of the water column and rest loosely upon the bottom. The coarse nature of the bottom sediments would not be conducive to firm binding of these materials, consequently these materials may be moved from one area to another in response to bottom currents, especially those generated by storm action.

The summer cruise, Operation "Deep Six", will have as objectives:

1. Extend the monitoring observations of the ocean dumping activities at selected previously observed locations, and at three

new stations west of previous areas covered. The water column and the bottom will be examined.

2. Observed dispositional trends of metals and accumulation in the sediments and the biota under stratified hydrographic conditions pertained in summer.

3. Expand the hydrographic information as related to the distribution of pollutants.

4. Examine for evidence of discrete patches of disposed materials. A sample on the previous cruise indicated that there may be areas in which material is accumulating, either through too rapid a dump or by environmental conditions causing accumulation.

5. Incidentally gather baseline data of environmental conditions at potential oil drilling sites using the normal reference stations of the ocean dumping monitoring program.

A complementary cruise in cooperation with NOAA and the USGS is planned on August 7, 8 and 9, in which the R/V Atlantic Twin and a two-man submersible, the Nekton boat, plan a series of dives and observations on these dumpsites. The objectives of the submersible program include:

1. Examine for evidence of discrete falls of material as may happen from a rapid dump, especially when there is no thermocline established and has been suggested by the extreme variability of replicate bottom samples encountered on some occasions. The sewage sludge material may appear as dark black patches in the bottom and

the resultant materials from the acid wastes may appear as flocs or slurries close to the bottom.

2. Examine for possible temporary entrapment of these materials in the microtopography. Conversely, determine the stability of these materials, if they are concentrating in swales, by deliberate disturbance of this material and watch visually for transport. If possible, selective sampling should be accomplished. Analyses will be done by EPA. Make a systematic observation of the order of magnitude of the bottom relief on an approximately 100-meter square area. This would greatly expand our concepts of the bottom topography and transport mechanisms of the area.

3. Observe currents close to the sea floor by visual estimation of the movement of either indigenous materials in the area or by the release of some sort of neutrally buoyant marker such as a dye material. Currents very near to the sea floor, less than one meter, are difficult to observe or record by meters, and these observations would be invaluable.

4. There is evidence that the flocculent materials released from the acid waste dumpsite accumulate in the thermocline under summer conditions. Visual observations of the thickness and estimates of the length and breadth of these accumulated materials in the pycnocline will be of great value in the design of further sampling from shipboard.

Operation "Deep Six"

Stations

Station No.	Latitude	Longitude	Loran A 3H4	 3H5
2	38°22.3' N	74°14.2' W	3356	3009
8	38°20.7' N	74°19.0' W	3313	3018
9	38°11.9' N	74°32.9' W	3217	3051
14	38°27.8' N	73°57.0' W	3500	2968
17	38°12.1' N	74°28.3' W	3181	3030
18	38°40.6' N	74°10.5' W	3557	3032
19	38°40.7' N	74° 0.0' W	3610	2996
20	38°34.2' W	74°22.8' W	3430	3060
21	38°32.8' N	74°08.5' W	3490	3009
22	38°27.2' N	74°26.0' W	3345	3053
24	38°17.0' N	74°14.5' W	3305	2998
25	38°13.0' N	73°57.8' W	3346	2936
26	38°05.2' N	74°27.7' W	3110	3017
27	38°05.2' N	74°13.4' W	3182	2974
28	38°47.8' N	74°20.0' W	3571	3080
29	38°47.8' N	74°10.0' W	3640	3047
31	38°40.2' N	74°30.5' W	3450	3094
32	38°32.1' N	74°31.2' W	3372	3079
33	38°22.8' N	74°32.7' W	3275	3063
A	38°40.6' N	74°19.5' W	3512	3065
B	38°35.1' N	74°18.1' W	3440	3048
C	38°31.2' N	74°19.5' W	3420	3043
D	38°28.5' N	74°17.0' W	3401	3030
E	38°23.5' N	74°18.2' W	3350	3025
F	38°13.6' N	74°08.7' W	3264	2985

Operation "DEEP SIX"
August 12-17, 1974

Scientific Party

Port Watch	Starboard Watch
W. Muir, Captain	D. Lear, Captain, Chief Scientist
R. Davis	W. Thomas
E. Truesdell	B. Reynolds
A. Montague, Project Officer	J. Kafka
W. Rosenberg	T. Dignes
A. Benosa	F. Hamons

Operation "DEEP SIX"
August 12-17, 1974
Sample Processing

SEDIMENT SAMPLES

	HONCHO			
Big Winch	Port	Starboard	Container	Preservative
A. Shipek (4 Replicates)				
1. 1st Replicate				
a. Bacti		Lear	Fr. sq.	Process
b. Organo-halogens	Davis	Kafka	Pt. Mason	Stow
c. TOC	"	"	Glass	Freeze
d. Metals	"	"	Plastic jar	Freeze
e. Sediment size	"	"	Jar	Stow
2. 3 Replicates				
a. Infauna	"	"	Gal. jar	5% Formalin
B. Trawl				
1. Macrofauna (I.D.)	"	"	Process (I.D.)	
2. Macrofauna (metals)	"	"	Plastic bags	Freeze
C. Rocking chair dredge				
1. Macrofauna (Histo.)	Truesdell	Reynolds	Drums	Formalin
2. Macrofauna (Metals)	"	"	Bags	Freeze

WATER SAMPLES

Hydrowinch				
A. Hinge Sampler				
1. Bacti		Lear	Fr. Sq.	Process
B. Niskin Bottles				
1. Metals	Davis	Kafka	Gal. cubi	Freeze
2. TOC	"	"	Whirlpak	"
3. Nutrients	"	"	Qt. cubi	"
4. Phytoplankton grab	"	"	Fr. Sq.	Lugol's soln.
C. Zooplankton Tow				
1. I.D. sample	"	"	Glass	Formalin
2. Metals	"	"	Whirlpak	Freeze

Operation "DEEP SIX"
August 12-17, 1974

STATION ROUTINE

	Watch	Honcho
Hydro Winch		
Operator	Port	Montague
	Stbd.	Thomas
BT	P	Rosenberg
	S	Dignes
Hydrocast	P	Rosenberg
	S	Dignes
pH	P	Rosenberg
	S	Dignes
D.O.	P	Rosenberg
	S	Dignes
Bacteriology	P	Benosa
	S	Lear
Zooplankton	P	Rosenbert
	S	Dignes
Big Winch		
Operator	Port	Muir, Watch Captain
	Stbd.	Lear, Watch Captain
Shipek	P	Davis
	S	Kafka
Trawl	P	Benosa
	S	Hamons
Rocking Chair Dredge	P	Truesdell
	S	Reynolds
Bacteriology	P	Benosa
	S	Lear
Samples (all)	P	Davis
	S	Kafka

Special Stations

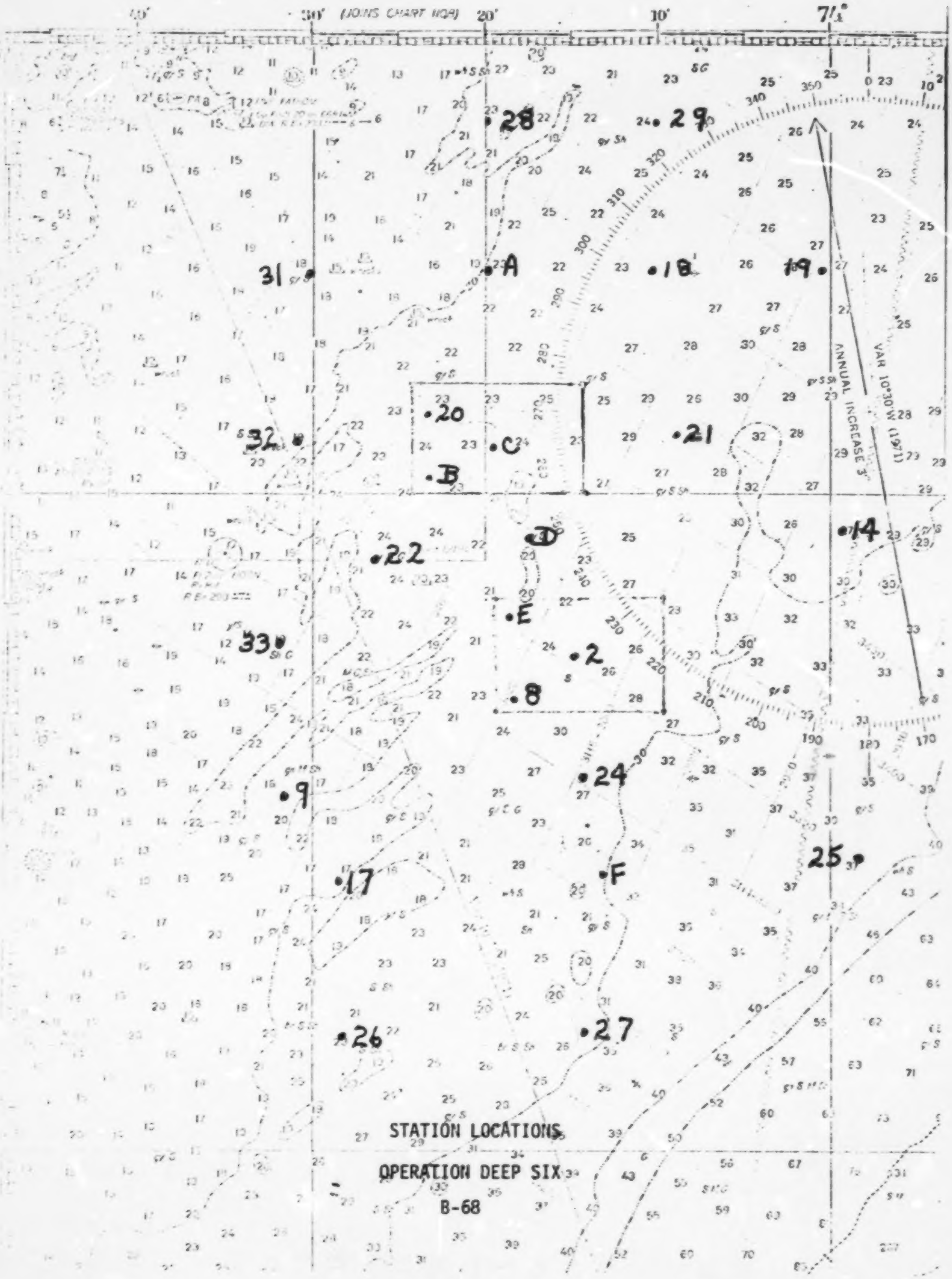
1. Current meter deploy and retrieve
2. Local bathymetry

Operation "DEEP SIX"
August 12-17, 1974

Parameter	Sampler	Number Stations	Samples/ Stations	No. of Analyses	Container	Preservative	Analyst	Data Inter.
SEDIMENTS								
Bacti	Shipek	8	1	8	Fr. Sq.	Process	On board	AFO
Organo-halogens	"	8	1	8	Pt. Mason	Stow	AFO	AFO
TOC	"	25	1	25	Glass	Freeze	AFO	AFO
Metals	"	25	5 at 8 1 at 17	45	Plastic jar 1 " " 2	" "	AFO Contract	AFO AFO
Sediment Size	"	25	1	25	Jar	Stow	AFO	AFO
Infauna	"	25	3	75	Gallons	5% Formalin	Contract	AFO
WATER								
Bottom Bacti	Hinge sampler	8	1	8	Sterile Fr. Sq.	Process	On board	AFO
Bottom Metals	Niskin	25	1	11	Gal. cubi	Freeze	Contract	AFO
Bottom TOC	"	25	1	1	Whirlpak	"	AFO	AFO
Nutrients - TP, Pi, NO_3, TKN	"	25	4	4	Qt. cubi	"	AFO	AFO
BIOLOGY								
Benthic Macrofauna	Rocking chair	25	1	-	Drums	Formalin	Narra-gansett	
Metals in Macrofauna	"	25	1	11	Bags	Freeze	Narra.	Narra.
Benthic Macrofauna	Trawl	25	1	-		Process (ID)	On board	AFO
Metals in Macrofauna	"	25	1	-	Plastic bags	Freeze	AFO	AFO
Phyto-plankton	Niskin	25	1	1	Fr. Sq.	Lugol's soln.	Contract	AFO
Zooplankton ID	Tow	25	1 } split	2	Glass	Formalin	Contract	AFO
Metals	"	25	1	11	Whirlpak	Freeze	AFO Contract	AFO

Operation "DEEP SIX"
August 12-17, 1974

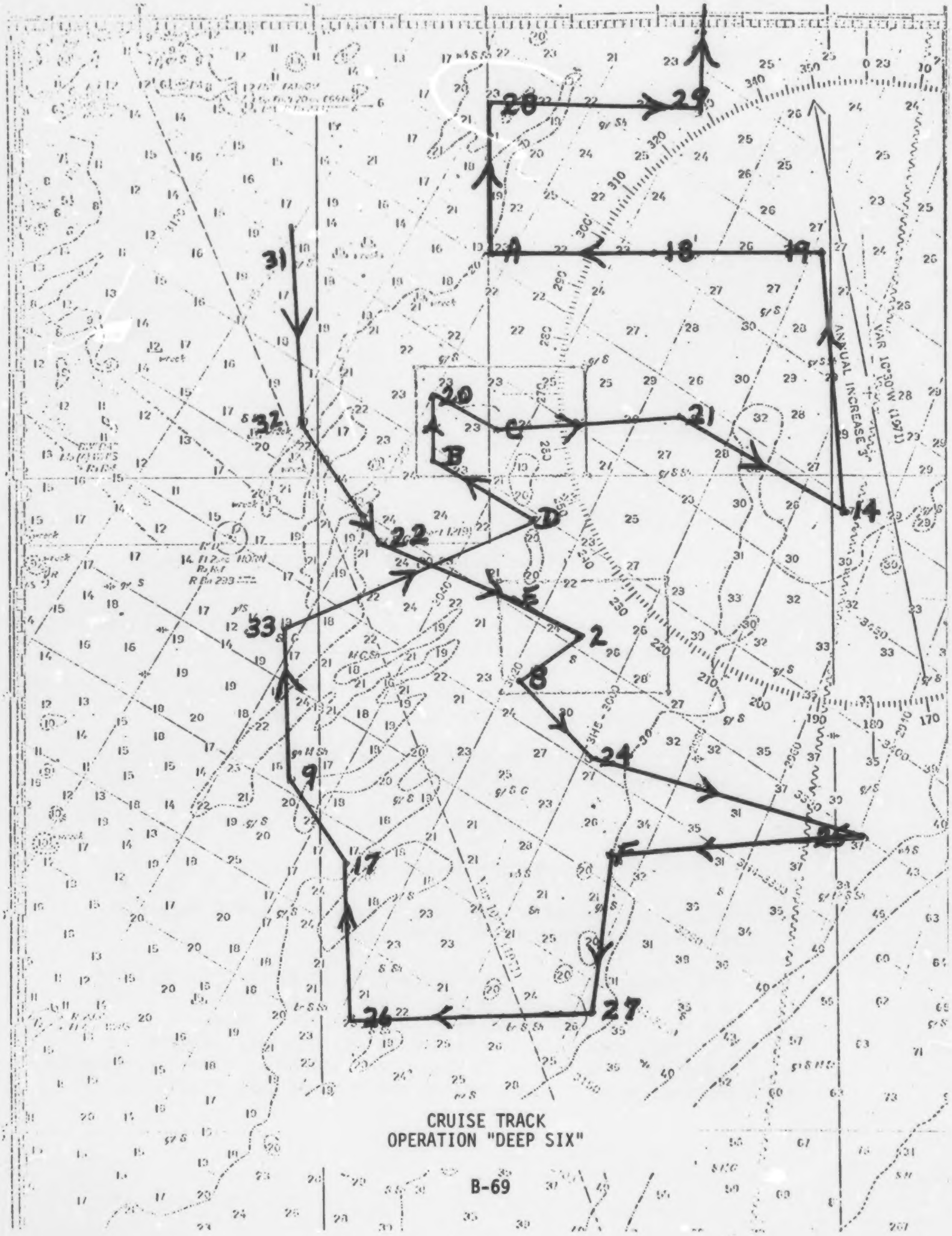
		Bottom Water				Sediments									
Sta.	C-S-T D.O. pH	Bacti	Metals	TOC	Water Col. Nutrients 4 Depths	Bacti	TOC	Pest.	Metals	Sed. Size	Biol.	Trawl	Dredge	Phyto Grab	Zoop Tow
31	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
32	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
22	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
E	✓	✓	✓	✓	✓	✓	✓	✓	5	✓	3	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓		5	✓	3	✓	✓	✓	✓
8	✓	✓	✓	✓	✓	✓	✓	✓	5	✓	3	✓	✓	✓	✓
24	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
25	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
F	✓		✓	✓	✓		✓		5	✓	3	✓	✓	✓	✓
27	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
26	✓	✓	✓	✓	✓	✓	✓	✓	1	✓	3	✓	✓	✓	✓
17	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
9	✓	✓	✓	✓	✓	✓	✓		1	✓	3	✓	✓	✓	✓
33	✓		✓	✓	✓		✓	✓	5	✓	3	✓	✓	✓	✓
D	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
B	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
20	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
C	✓	✓	✓	✓	✓	✓	✓	✓	5	✓	3	✓	✓	✓	✓
21	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
14	✓	✓	✓	✓	✓	✓	✓	✓	5	✓	3	✓	✓	✓	✓
19	✓	✓	✓	✓	✓	✓	✓		1	✓	3	✓	✓	✓	✓
18	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
A	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓
28	✓		✓	✓	✓		✓	✓	5	✓	3	✓	✓	✓	✓
29	✓		✓	✓	✓		✓		1	✓	3	✓	✓	✓	✓


40'
30'
(JOINS CHART 1109)
20'
10'
71°
28
29
A
18
19
31
20
C
B
21
32
D
22
14
E
2
8
33
24
9
25
17
F
26
27
ANNUAL INCREASE 3'
VAR 10°30'W (1971)

STATION LOCATIONS

OPERATION DEEP SIX

B-68


28
29
A
18
19
31
20
B
C
21
32
14
D
22
E
33
2
8
24
25
F
9
17
26
27
VAR 10°30'W (1971)
ANNUAL INCREASE 3'

CRUISE TRACK
OPERATION "DEEP SIX"

Hydro Winch Routine

1. Log in position on station.
2. Take BT
3. Determine depth of thermocline
4. Make Hydrocast

    Surface
    1/2 way to thermocline
    1/2 way thermocline to bottom
    Bottom (Hinge sampler also on bacti stations)

5. Draw sample for D.O. determination. Log in D.O.
6. Draw sample for pH. Log in.
7. Fill quart cubitainer (label with date, time, station no.) Freeze in Blood box.
8. Fill 8 oz. French square, add Lubol's iodine until it looks like weak tea. Label. Store. Surface samples only.
9. Fill 8 oz. French square full for salinity determination, label with date, time, station, depth. Store.
10. Fill gallon cubitainer with residual bottom water only. Label. Freeze for metals analysis.
11. Give hinge sampler to bacteriologist for analysis.
12. Take Secchi disc reading during daylight hours.
13. Take temp., salinity and conductivity at 5-meter intervals with Beckman induction salinometer.
14. Take zooplankton tow during trawling or dredging operations. Surface tour for 15 minutes. Place in pint Mason jar, fill 3/4 full with sea water from this station. Place in plankton splitter, place 1/2 in labeled 16 oz. whirlpak, freeze. Place other half back in Mason jar, add 60 ml formalin, make up with sea water. Label inside and outside jar, store.

STATION LOG

Hydrographic Winch

Sta. No. ________ Time ________ Date ________

Position ________ ________ Depth ________

Wind Dir. ________ Vel. ________ Sea state ________

BT time ________ Secchi disc ________

Depth	Cond.	Sal. °/oo	Temp.	D.O.	pH

Bacti sample ☐ Salinity sample ☐

Phytoplankton sample ☐ Zooplankton tow ☐

Time secured __________ Position _____ _____

Big Winch Routine

1. Log in position on station.
2. 1st Shipek drop.
    - a. Take bacti sediment with flame-sterilized metal mud scoop. Put into 6 oz. French square with 100 ml distilled water. Give to bacteriologist.
    - b. Fill a pt. Mason jar with teflon liner for organohalogens (Label with date, time, sta. no.) Stow.
    - c. Fill a white plastic metals jar. Freeze in blood box.
    - d. Fill 6 oz. Fr. sq. for TOC. Freeze in blood box.
    - e. Fill 16 oz. whirlpak with sediment for size analysis. Stow.
    - f. Core 40 dram labeled vial, add 20 ml formalin. Stow.
3. 3 Shipek replicates
    - a. Fill white plastic metals jar at indicated stations. Freeze in blood box.
    - b. Empty bucket into plastic bag. Take to sample area, put into 1 gal. polyethylene jar with 500 ml formalin. Label inside and out with date, time, sta. no.
4. Rocking chair dredge
5. Trawl
    - a. Identify and estimate number of macrofaunal species.
    - b. Take representative species for metals analyses. Put in plastic bags. Label and freeze in blood box.

Keep trawl rigged for next station. Will laternate with rocking chair dredge to save onrigging time.

STATION LOG
Big Winch

Sta. No. ______ Time ______ Date ______

Position ______ ______ Depth ______

Wind dir. ______ Vel. ______ Sea state ______

Shipek drops

- Bacti sample ☐
- Size analysis sample ☐
- Infauna samples ☐
- Organohalogens ☐
- TOC ☐
- Metals ☐

Rocking chair dredge

Position out ______ ______ Time out ______

Position in ______ ______ Time in ______

Organisms: ______

Trawl

Position out ______ ______ Time out ________

Position in ______ ______ Time in ________

Organisms: ____

Observations

APPENDIX C

Philadelphia Sewage and DuPont Acid
Dump Site Survey
7-9 August 1974

Dr. David Folger
U.S. Geological Survey
Woods Hole, Massachusetts

Vessel: T/V Atlantic Twin - Tom Anderson, Master

Submersible: NEKTON GAMMA - Terry Shiller, Pilot

Scientific Observers: D. Folger, USGS, Sea Scientist
B. Reynolds & G. Morrison, EPA
H. Palmer & Jo. Forns, Westinghouse
F. Childress, MUS&T
B. Oostdam, Marine Science Consortium

Fourteen dives were carried out in and around the two dumpsites located about 40 nautical miles southeast of the mouth of the Delaware Bay. The study was part of a coordinated effort involving surface ships R/V ANNANDALE, R/V ADVANCE II, Erts Overpass, and the sewage release by the City of Philadelphia.

The eight dives carried out at five locations in the Philadelphia site lay along or close to the track of the barge which released sewage on 7 August. Unfortunately, only one dive near the area preceding the dump also was made on the 7th. Winds of 30-40 knots precluded additional dives. The remaining seven dives took place on the 8th and 9th. A summary of observations is as follows:

Water Column - The thermocline lay between about 12 and 30 meters with a temperature decline of about 23°C to 12°C. Highest turbidity occurred in and below the thermocline although no significant variations with depth were often noted by observers. Bottom currents were sluggish (2-5cm/sec) and moved mostly to the NW or NE. One observation showed flow to the east.

Bottom - In the northwest part of the site, the bottom topography is relatively flat with common small hummocks and depressions (about 15cm diameter, 5cm high or deep). In the central and southeast parts of the area ripples are common. Wavelengths measured were about 30cm to 100cm and wave height 2-5cm. Most are symmetrical with broad flat tops oriented northwest to southeast. The bottom is partially to almost completely covered by a thin (2-3mm) veneer of brownish gray flocculated material below which light tan to gray, fine to coarse, sand is present. The floc material was often absent or thin on ripple and mound crests and was usually present and thickest in depressions. Shell detritus on the bottom most often included sea flams, razor clams and sand dollars. Empty shells generally lay concave side up. Bottom depth was between 140-180 feet.

Biology - Among living organisms on the bottom, sand dollars were most abundant (20-180/meter^2) with less common shrimp (<100/meter^2) and starfish (10/meter^2). Sea scallops were most abundant (3-4/meter^2) in the southeast part of the dumpsite. Other less common organisms included crabs, nudibranchs, flounder, and hake.

In summary, no obvious layer of settling sludge was apparent in the water column nor were sludge accumulations on the bottom identified. The sludge, in part, may account for the flocky layer on the bottom but it was a consensus of experienced observers that the layer could have been due to natural processes. In any event, its distribution on the bottom clearly indicates that fine organic detritus will concentrate in swales, ripple trough, and depressions. The biologists did not note any obvious significant disruptions of the faunal and floral bottom community.

In the acid dumpsite, 5 dives were carried out at 4 locations. One took place on the 7th of August while the remainder took place on the 9th. The results are as follows:

> Water Column - Thermocline lay between 11-30 meters with a temperature decline from 23°C - 12°C. No distinctive differences in water column turbidity during the dive carried out on the 7th or on the dives on the 9th in the southeast corner of the site were noted. Near the center of the site, however, light green water was observed at the surface extending east-west in about 1/2 nautical mile wide. Two dives carried out in this green water revealed increased turbidity above and in the thermocline. On one dive in this area, a layer of 0° visibility extended from 6-9 meters and was overlain by a zone (12-15 meters) containing abundant large (1-3cm diameter) reddish-yellow flocs. Fine suspended material, similar to that observed at other locations, was present above and below the two zones. The pH of the water above about 15 meters was reduced and the anomalous water was probably due to the most recent acid dump. Bottom current flow measured at two locations was northward and 4-5cm/second.

Bottom - The bottom was either humocky (10cm diameter; 1-5cm/high) or had ripples (wavelengths 15-75cm; 1-5cm high) oriented mostly northeast to southwest or north-south. At one location, ridges and swales were present with a 3-5 meter wavelength. The surfacial layer on the bottom was comprised of patchy deposits of flaky to granular yellow brownish material usually left thin (2mm thick). The loose flocky material common in the sewage site was rare. The underlying gray fine sand was commonly exposed on ripple and mound crests. Shell fragments included mostly sea clams, razor clams, and sand dollars. Bottom depth was between 140-180 feet.

Biology - Sand dollars were often the most common organisms (180-270/meter^2); crab and blood stars were the next most common. Juvenile flounder, skates, scallops, and hake were present but not as abundant.

In summary, the low visible layer and the underlying zone containing large red yellowish flocs above and in the thermocline were the major anomalies observed in the site. The lack of a flocculated layer on the bottom may be related to acid additions but this possiblity cannot be proven without further observations.